GOVERNMENT NOTICE

DEPARTMENT OF ENVIRONMENTAL AFFAIRS AND TOURISM

No. R. 613 **28 May 2009**

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

VAAL TRIANGLE AIR-SHED PRIORITY AREA AIR QUALITY MANAGEMENT PLAN

I, Marthinus Christoffel Johannes van Schalkwyk, Minister of Environmental Affairs and Tourism, hereby in terms of section 19(5)(a) of the Act, publish the Vaal Triangle Air-shed Priority Area Air Quality Management Plan, as set out in the Schedule hereto.

Marthinus van Schalkwyk

MARTHINUS VAN SCHALKWYK,
MINISTER OF ENVIRONMENTAL AFFAIRS AND TOURISM

environment & tourism

Department:
Environment Affairs and Tourism
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF ENVIRONMENTAL AFFAIRS AND TOURISM

Environmental Quality and Protection

Chief Directorate: Air Quality Management and Climate Change

VAAL TRIANGLE AIRSHED PRIORITY AREA AIR QUALITY MANAGEMENT PLAN

2009

EXCECUTIVE SUMMARY

1. INTRODUCTION

The declaration of the Vaal Triangle Airshed as a priority area was published in the Government Gazette in terms of Section 18(1) of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) under Notice No. 365 of 21 April 2006, as amended by Notice 711 of 17 August 2007. The Vaal Triangle Airshed Priority Area (VTAPA) is the first priority area in South Africa and was declared such due to the concern of elevated pollutant concentrations within the area, specifically particulates. The geographical location of the area is provided in Figure A.

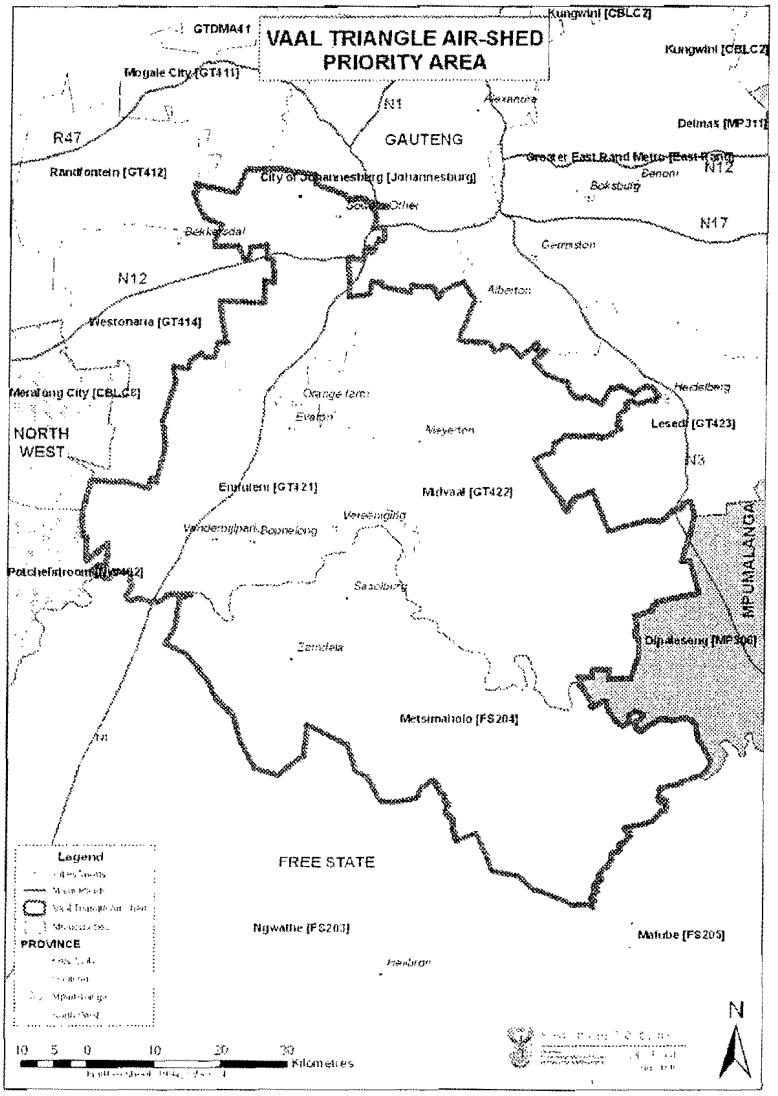

Figure A: Demarcation of the Vaal Triangle Airshed Priority Area

The Vaal Triangle is a highly industrialised area housing numerous industries, a coal fired power station, and various smaller industrial and commercial activities in addition to a few collieries and quarries giving rise to noxious and offensive gasses. The Vaal Triangle is also home to a number of large informal settlements mainly using coal and wood as fuel source. This in return impacts directly on the health and well being of the people residing there. Other sources of concern contributing to the pollution mixture within the area include vehicle tailpipe emissions, biomass burning, water treatment works and landfill areas, agricultural activities and various other fugitive sources.

*The **main objective** was the development of an Air Quality Management Plan for the Vaal Triangle Airshed Priority Area in accordance with the provisions of the National Environmental Management: Air Quality Act, 2004. This Plan is to ensure that once implemented, the air quality of the area will effectively and efficiently be brought into sustainable compliance with National Ambient Air Quality Standards within agreed timeframes.*

Air quality management is primarily the minimisation, management and prevention of air pollution, which aims to improve areas with poor air quality and maintain good air quality throughout. The complex nature of air quality issues within the VTAPA required the adoption of a holistic approach to air quality management in the area. This approach was followed during the development of the VTAPA Air Quality Management Plan (AQMP).

As part of the requirements for priority areas according to the National Environmental Management: Air Quality Act, 2004 (AQA) an AQMP needs to be developed for the area within a given timeframe. A consulting team comprising of Airshed Planning Professionals, Gondwana Environmental and Zitholele Consulting was appointed by the Department of Environmental Affairs and Tourism (DEAT) to assist in the compilation of an AQMP for the VTAPA. Another objective of the project was to capacitate the local authorities who will be responsible for air quality management under AQA.

In order to meet these objectives, immediate goals included:

(a) The development of participation forums to ensure inter-governmental communication (Air Quality Officer's Forum) and interaction but also close cooperation with the key stakeholders (Multi-Stakeholder Reference Group) in the Vaal Triangle.
(b) The planning objective which entails the methodology and scope of developing and implementing a priority area air quality management plan.
(c) Capacity development to ensure that the various spheres of government (viz. National Government, Provincial Government and District and Local Municipalities) are empowered to implement and maintain the AQMP for the priority area.

The immediate project objectives and related outputs are summarised in Table A.

Reference was made to international and local air quality practices to ensure the plan forms an integral and practical system that will meet the objectives as defined in Table A. Local municipalities that have developed AQMPs to date include the City of Johannesburg (partly falling within the VTAPA), the City of Tshwane, Ekurhuleni Metropolitan Municipality (bordering the VTAPA), Rustenburg Local Municipality, the City of Cape Town, eThekwini Metropolitan Municipality and Capricorn District Municipality. The plans developed by the City of Johannesburg, the City of Cape Town and eThekwini Metropolitan Municipality (based on the Durban South Multipoint Plan) were described in more detail. In addition, various cities across the world (ranging from

developed to developing countries) were investigated and information provided on their air quality management practices, strategies and progress made to date.

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

Immediate Objective	Output	Verifiable Indicator	Means of Verification
A. The Participation Objective	A.1. Efficient and effective intergovernmental coordination and cooperation	Efficient and effective intergovernmental coordination and cooperation.	Meeting Minutes.
	A.2. Efficient and effective public participation	Efficient and effective public participation.	Meeting Minutes and stakeholder feedback.
	A.3. Project website	A project webpage containing current and relevant information relating to the project as available through the department's website.	Stakeholder feedback and webpage hits.
	A.4. Public outreach events and workshops	Well organised public events ensure broad-based public participation.	Event report and feedback.
B. The Planning Objective	B.1. Process Plan	A clear and unambiguous plan on how Output B is to be generated.	Implementation of the process plan results in the desired outcome.
	B.2. Problem Analysis	The causes of current and, potential, future poor air quality in the area are clearly defined and described.	The efficiency of the plan is ensured through interventions that deal with the real causes of poor air quality in the area.
	B.3. Strategy Analysis	All possible pollution mitigation strategies are described and reviewed.	The plan is directed by practical strategies that ensure a high probability for success.
	B.4. Intervention Descriptions	Interventions are clearly described that, once implemented, will have a measurable positive impact on ambient air quality in the area.	The plan describes interventions that ensure a high probability for success.
	B.5. Draft Priority Area Air Quality Management Plan	A draft plan based on current, accurate and relevant information, informed by best practice in the field of air quality management and that provides a clear and practical plan to efficiently and effectively bring air quality in the area into sustainable compliance with National Ambient Air Quality Standards within agreed timeframes.	Draft plan published in the *Gazette* for public comment.
	B.6. Priority Area Air Quality Management Plan	A plan based on current, accurate and relevant information, informed by best practice in the field of air quality management and that provides a clear and practical plan to efficiently and effectively bring air quality in the area into sustainable compliance with National Ambient Air Quality Standards within agreed timeframes.	Plan published in the *Gazette*.
C. The Capacity Development Objective	C.1. Implementation Manual	Implementation Manual for Air Quality Management in Priority Areas.	Published manual.
	C.2. National Priority Area Management Capacity	Active involvement of departmental staff in the implementation of the project.	Staff able to efficiently and effectively manage future priority areas.
	C.3. Implementation Initiated	Assistance provided in the initial plan implementation phase.	Implementation successfully launched.

1.1 Policy and Regulatory Requirements

The AQA makes provision for the setting of ambient air quality standards and emission limits on National level, which provides the means of evaluating air quality. In addition, the AQA requires the development of a National Framework (published under Notice No. 30284 of 11 September 2007) which provides national norms and standards for air quality management, ensuring compliance be achieved with ambient air quality standards and emissions limits.

National, Provincial and Local authorities (District and Metropolitan Municipalities) will be responsible to manage air quality under the National Environmental Management: Air Quality Act, 2004.

Section 15 of the Act requires that each national department or province responsible for preparing an environmental implementation plan (EIP) or environmental management plan (EMP) in terms of Chapter 3 of the National Environmental Management Act, 1998 (Act No. 107 of 1998) include in that plan an air quality management plan (AQMP). Each municipality must include in its integrated development plan (IDP) contemplated in Chapter 5 of the Municipal Systems Act, an air quality management plan. An AQMP must achieve the following: (i) improve air quality; (ii) reduce negative impacts on human health and the environment; (iii) address the effects of fossil fuels in residential applications; (iv) address the effects of emissions from industrial sources; (v) address effects from emissions from any point or non-point sources of air pollution; (vi) implement the republic's obligations in respect of international agreements; and, (vii) give effect to best practice in air quality management. AQA also provides for regulations to be made for implementing and enforcing approved priority area AQMPs, which may include, amongst others: (i) funding arrangements; (ii) measures to facilitate compliance with such plans; (iii) penalties for any contravention of any failure to comply with such plans; and (iv) regular review of such plans. The approved AQMP for a priority area must be published in the Gazette within 90 days of approval.

AQA has delineated the responsibility of air quality management between the various spheres of government (i.e. National, Provincial and Local Authorities). This includes responsibilities such as air quality monitoring, emissions monitoring, development of AQMPs, collaboration with National and Provincial government and issuing atmospheric emissions licenses for all listed activities. In order to fulfil these functions Local authorities will have to appoint a dedicated Air Quality Officer. Provincial authorities will be responsible for similar functions as would national government. On national level however the focus is more on policy making and regulations.

DEAT has embarked on various projects to roll out the AQA. These projects include amongst others the Durban South Multipoint Plan, NEDLAC Dirty Fuel Air Quality Study, SO_2 ambient standard setting initiative, the SABS standard setting approach, the Danida support NAQMP Phase II and IIB Projects, the APPA Registration Certificate Review Project, National Framework for Air Quality Management, Listed Activities and Minimum Emissions Standard Setting Project, and DEAT Ambient Air Quality Monitoring Project.

1.2 Ambient Air Quality Standards for the Vaal Triangle Airshed Priority Area

Air quality limits and thresholds are fundamental to effective air quality management, providing the indicators to safe exposure levels for the majority of the population. Health based ambient standards have been developed for criteria pollutants internationally and locally. The current South African standards have been revised and were published for comment under Notice No. 528 on 9 June 2006. The newly proposed standards include particulate matter specifically PM_{10} (particulates with a diameter of less than 10 micrometres), sulphur dioxide (SO_2), oxides of nitrogen (NO_x), ozone (O_3), lead, carbon monoxide (CO) and benzene. These revised standards have been adopted as the VTAPA air quality objectives (Table B). The revised National Ambient Air Quality Standars are undergoing the Standard Setting process and will be published with allowable frequency of exceedances linked to it and compliance timelines provided.

Table B: Ambient Air Quality Limits for Common Pollutants as adopted to be the Air Quality Objectives for the Vaal Triangle Airshed Priority Area.

Substance	10-minute maximum ($\mu g/m^3$)	1-hour maximum ($\mu g/m^3$)	8-hour maximum ($\mu g/m^3$)	24-hour maximum ($\mu g/m^3$)	Annual average ($\mu g/m^3$)
Sulphur dioxide (SO_2)	500	350	-	125	50
Nitrogen dioxide (NO_2)	-	200	-	-	40
Carbon Monoxide (CO)	-	30 000	10 000	-	-
Particulate Matter (PM10)	-	-	-	75	40
Ozone (O_3)	-	200	120	-	-
Lead (Pb)	-	-	-	-	0.5
Benzene (C_6H_6)	-	-	-	-	5

2. VAAL TRIANGLE AIRSHED PRIORITY AREA AIR QUALITY SITUATION ASSESSMENT

The demarcation of the VTAPA includes two district municipalities and one metropolitan municipality namely Sedibeng District Municipality (Gauteng Province), Fezile Dabi District Municipality (Free State Province) and the City of Johannesburg Metropolitan Municipality (Gauteng Province). The Local municipalities include Emfuleni Local Municipality and Midvaal Local Municipality in Sedibeng, Administrative Regions 6 (Doornkop/Soweto); 10 (Diepkloof/Meadowlands), and 11 (Ennerdale/Orange Farm) within the City of Johannesburg; and the Metsimaholo Local Municipality (Northern Free State) (Figure A). The priority area covers approximately 3,600 km^2 and houses a population of ~2,532,362 (based on the 2001 Census) with the highest population density falling within Soweto and Emfuleni Local Municipality.

2.1 Dispersion potential and ambient air quality of the Vaal Triangle Airshed

The dispersion potential varies spatially due to the extent and topography of the priority area. Surface meteorological data was obtained from weather stations owned and operated by (i) the South African Weather Services (at Vereeniging, OR Tambo Airport and Springs), (ii) industry (Sasol, ArcelorMittal and Eskom) and (iii) the City of Johannesburg (Jabavu and Orange Farm). No upper air meteorological data is recorded within the VTAPA and use was made of the South African Weather Services ETA data model results.

The spatial and annual variability in the wind field was evident in the wind roses presented. Stations located in the northeast of the priority area reflected predominant northerly winds associated with generally strong airflow. Stations in the east indicated more frequent easterly winds associated with low wind velocities. Towards the north-central parts of VTAPA, the wind flow was characterised by strong winds from the northwest to west-southwest. Around the Sasolburg area northwesterly, easterly and northeasterly winds were prevailing with northeasterly and west-southwestly winds dominating at the ArcelorMittal Vanderbijlpark Steel stations (DEAT, 2007).

2.2 Ambient Air Quality of the VTAPA

2.2.1 Ambient Monitored Air Quality Data

Ambient monitoring data were obtained from various monitoring stations within the area for the period 2004 to 2006. In the analysis and presentation of the monitoring data, reference was made to the VTAPA ambient air quality targets (also proposed South African Standards) and City of Johannesburg air quality guidelines.

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. The six DEAT stations that were commissioned between February and March 2007 had very limited data available at the time of the study and were omitted from the baseline assessment (DEAT, 2007).

2.2.2 Predicted Ambient Air Quality Data within the Vaal Triangle

In addition to the ambient monitored data, use was made of dispersion modelling to determine the spatial extend of the ambient concentrations within the VTAPA. This primarily served the function to establish "hot spot" zones or focus areas. The US.EPA approved CALMET/CALPUFF suite of models was used for the dispersion simulations.

A first level emissions inventory for the VTAPA was compiled based on information received through questionnaires, EIA reports and other public documents, and the NEDLAC Dirty Fuels study (Scorgie *et.al.* 2004). Criteria pollutants formed the focus of the impact assessment, with emissions of PM_{10}, SO_2 and NO_x accounted for. Of all identified sources, 88% provided emissions data with 12% of the source emissions not accounted for. Industry emissions were based on 2004 to 2006 data. Domestic fuel burning emissions were based on 2001 Census data for household coal, wood and paraffin use and only national and regional roads were included for the estimation of vehicle tailpipe emissions (DEAT, 2007).

2.3 Priority Pollutants within the VTAPA

Based on the available monitoring data, the major findings of the air quality assessment indicated that:

- ***Particulate (PM_{10})*** concentrations are elevated over most areas of the VTAPA, particularly in residential areas where domestic coal burning is occurring and areas neighbouring major industrial operations.
- ***Sulphur dioxide (SO_2)*** concentrations are generally below the VTAPA air quality objectives in both the residential and industrial stations, although exceedances were recorded on several occasions at Jabavu and Orange Farm and in Sasolburg.
- ***Nitrogen dioxide (NO_2)*** concentrations are low in the VTAPA, although a seasonal signature is observed in NO_2 concentrations. Nitrogen dioxide concentrations have a regional impact within the Vaal Triangle.
- ***Carbon monoxide (CO)*** concentrations are not considered to be significant in the VTAPA.
- ***Ozone (O_3)*** concentrations are elevated in areas surrounding major industrial operations with exceedances of the one-hour average target recorded on numerous occasions. Ozone concentrations measured at Makalu are representative of known background concentrations in South Africa.

2.4 Priority Sources within the VTAPA

All the sources within the VTAPA (i.e. industrial, power generation, domestic fuel burning, mining, vehicle emissions etc.) to a larger and lesser extent contribute to particulates (PM_{10}), with most of the industrial sources, power generation, domestic fuel burning, and vehicle tailpipe emissions contributing to SO_2 and NO_2.

2.5 Priority Areas

Hotspot zones within the priority areas where intervention strategies will take priority were identified based on the predicted ambient air concentrations from the priority pollutants and the exposure potential. Prioritisation of sources was ranked based on impacts rather than the extent of their emissions. This ensures that the main contributing sources resulting in non-compliance with the VTAPA ambient air quality objectives and hence pose the greatest risk to human health and the environment, be addressed as priority.

Simulated ground level concentrations, verified with ambient monitored data, indicated that the main pollutant of concern within the VTAPA is inhalable particulates (PM_{10}). Six priority areas were identified within the VTAPA based on highest PM_{10} concentration zones or "hotspots" (Figure B). 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 C for each of the identified priority zones (DEAT, 2007).

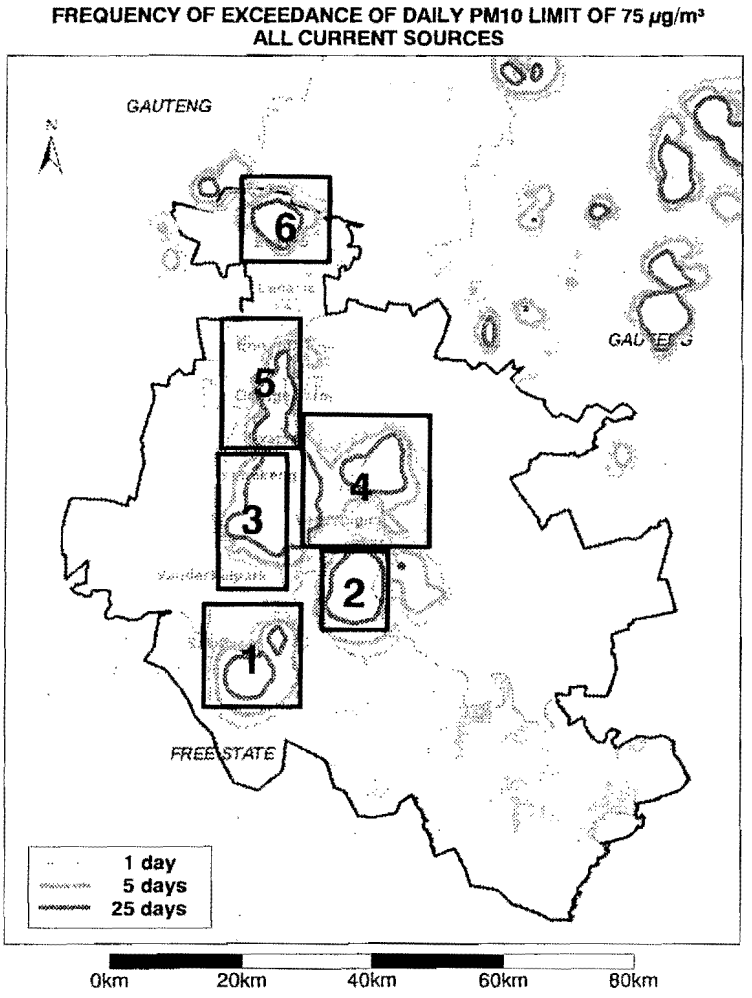

Figure B: Six priority "hotspot" areas identified within the VTAPA based on predicted PM_{10} ground level concentrations.

Table C: 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 brickworks 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

2.6 Capacity Assessment

Based on the capacity assessment of the various spheres of government (National, Provincial and Local), it is clear that there is an intentional drive from National Government (DEAT) to built capacity and implement the various components of the AQA. At National level, a Chief Directorate has been established for Air Quality Management and Climate Change with a Directorate specifically focusing on Air Quality Management. Subsequently, DEAT has established a sub-directorate clearly showing commitment to air quality management. DEAT will ultimately be responsible for the implementation and roll-out of the VTAPA AQMP. On provincial level, Gauteng has a Directorate devoted to Air Quality falling under the Chief Directorate Sustainable Use of the Environment. The Free State has a sub-directorate for Air Quality Management under the Directorate: Environmental Quality.

At local government level, the City of Johannesburg is probably the most experienced on air quality management with an AQMP already implemented in 2003. This AQMP is currently undergoing the first review period. Both Ekurhuleni Metropolitan Municipality and the City of Tshwane followed by developing AQMPs in 2004 and 2006, respectively. Within the Sedibeng District Municipality air quality are managed by Environmental

Health Services with most of the air quality responsibilities being that of the Environmental Health Practitioners. Similarly, Environmental Health Practitioners are responsible for all air quality related functions at Local Municipal level. This include amongst others, compiling and updating emissions inventories on all small boiler operations within the municipality. With the exception of Emfuleni Local Municipality, no complete inventory exists. Other functions include diesel vehicle testing and air quality related complaints attendance.

The shortfalls have mainly been identified as the lack of interaction among the various spheres of government and among municipal departments. This results in duplication of work or the neglect of functions. In addition, systems and procedures in place at most municipal departments to manage air quality are inadequate. A communication and reporting framework will form part an important part of the AQMP implementation (DEAT, 2007).

3. METHODOLOGY FOR THE DEVELOPMENT OF AN AIR QUALITY MANAGEMENT PLAN

The main steps in the compilation of an AQMP for VTAPA included the following:

- Problem identification: Does current air quality monitoring suggest that there is a problem? What factors or sources are contributing to this problem?

- Plan development: What are the most appropriate air-emission reduction measures to achieve local goals, and what are the relative priorities?

- Implementation and reporting: How and when will the measures be implemented, and by whom? How often will progress be reviewed and reported upon? (Williams and Bhattacharyya, 2004)

The Logical Framework Approach (LFA) (NORAD, 1999) methodology was followed:

- Situation Analysis (including Stakeholder Analysis, Problem Analysis, Objective Analysis);
- Strategy Analysis;
- Project Planning Matrix (including the Matrix, Assumptions, Objective Indications, Verification); and,
- Implementation.

4. PROBLEM IDENTIFICATION AND OBJECTIVES ANALYSIS

A problem tree was developed for an identified problem around which cause and effect relationships were established. These problems were then restated into achievable objectives that will result in the desired outcome for the VTAPA, which is an acceptable air quality in the region. Using the LFA approach, the main problems and critical gaps associated with air quality and the management thereof were identified through an initial characterisation of the existing situation in the VTAPA. The Baseline Assessment determined the existing air quality in the region, identified problem sources and areas through dispersion modelling and ambient monitoring, and assessed capacity for air quality management within all spheres of government. Subsequently, information obtained from this initial assessment was used to identify the major problems in the region and develop corresponding objectives to correct these problems.

Using this methodology, **eleven** problem complexes were identified around which problem and associated objectives trees were developed. A problem complex is a set of problems with similar cause and effect relationships that are not necessarily related to a specific location. These have been divided into 'emission' problem complexes and 'non-emission' problem complexes. Emission problem complexes identified included (listed alphabetically and not according to significance) (i) Biomass Burning, (ii) Domestic Fuel Burning, (iii) Iron and 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 (DEAT, 2007).

5. STRATEGY ANALYSIS AND INTERVENTION DESCRIPTIONS FOR THE IDENTIFIED PROBLEM COMPLEXES

Following the problem and objectives analysis, a strategy analysis was undertaken. Appropriate strategies were identified to develop feasible interventions addressing the eleven problem complexes. Various interventions have been proposed for each of the eleven problem complexes. These interventions also incorporate the suggestions from stakeholders within the VTAPA, based on the output from the problem and objectives analysis. It was however necessary to prioritise the interventions for implementation of the management plan, based on (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. Other considerations included the 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.

Action plans have been developed for selected interventions (Appendix B of main report). Where possible, dates were assigned to each intervention. If dates were unknown, generic timeframes ranging from short term (1 – 2 years), medium term (3 – 5 years) and long term (5 – 10 years) were assigned.

General concerns voiced by stakeholders are listed below and have been incorporated into the intervention strategies in the short and medium term. The main concerns include:

- 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 of 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.

Since the minimum emission standards setting process are primarily informed by Best Available Techniques (BAT) and the understanding that most of the sources within the Vaal Triangle Airshed Priority Area have conducted air quality studies in the past (mostly as part of EIAs where technology reviews are part of the investigation), the development of emission reduction strategies should not be a difficult task once all the above mentioned projects are completed. It was therefore agreed that additional time be granted to the various industries within the VTAPA to develop detailed emission reduction strategies. Industry and government departments (National, Provincial and Local) were given until June 2008 to submit detailed emission reduction strategies ensuring compliance with ambient air quality objectives within given timeframes. This information has been incorporated into the VTAPA AQMP.

Provided the importance of clear Air Quality Objectives (AQO) and margins of tolerance, air quality targets as indicated in Table D be proposed for VTAPA. The VTAPA Air Quality Objectives propose the revised national

ambient standards as published for public comment (Government Notice 263 in Government Gazette 31987 of 13 March 2009) as immediate targets, with allowable frequency of exceedances to ensure air quality improvement. These AQO should be updated once the final National Standards are published in September 2009.

Table D: Proposed Ambient Air Quality Implementation Targets for the Vaal Triangle Airshed Priority Area

Averaging Period	Pollutant	Concentration	Frequency of permitted Exceedance (FOE)	Compliance Date [(a)]
1 hour	SO_2	350 $\mu g/m^3$	88	2009
	NO_2	200 $\mu g/m^3$	88	
	CO	30 000 $\mu g/m^3$	88	
8 hour	CO	10 000 $\mu g/m^3$	11	2009
	O_3	120 $\mu g/m^3$	11	
24 hour	SO_2	125 $\mu g/m^3$	4	2009
	PM_{10}	75 $\mu g/m^3$	4	
Annual	SO_2	50 $\mu g/m^3$	0	2009
	NO_2	40 $\mu g/m^3$	0	
	PM_{10}	40 $\mu g/m^3$	0	
	Lead	0.5 $\mu g/m^3$	0	
	Benzene	5 $\mu g/m^3$	0	

Notes: (a) Compliance date will be initiated when the revised National Standards are published in September 2009

5.1 Biomass Burning

Vast open spaces within the VTAPA primarily used for agricultural activities are prone to veld fires specifically during the dry winter months.

Problem: High seasonal and localised emissions from biomass burning.

The main causes of such high localised impacts have been identified as:

- Accidental burning;
- Perceived and real benefits from burning;
- Current management strategies; and,
- Legal requirements (fire breaks).

Objective: To minimise the impacts from biomass burning on the surrounding environment and human health.

Interventions:

Proposed ***Short- term (2008/9)*** interventions are as follows:

- Identify the role of fire services to assist in air pollution control. The responsible parties include the local authorities of SDM, FDDM and COJ. Progress made to date includes the coordination and collaboration with local municipalities as done by SDM. The Community, Health and Environmental Services of FDDM are engaged with the Local Municipality Fire Departments and are in the process to investigate the feasibility of taking over the fire services.
- DEAT should develop an inversion early warning system that triggers a veld fire control response (as obtained from the meteorological data measured in the VTAPA). Such a system has not yet been developed.

Proposed ***Short – Medium term (2012)*** interventions are as follows

- The local authorities should identify and quantify emissions from biomass burning to be included into the VTAPA emissions inventory. SDM is in the process of establishing a sub-directorate to coordinate all air

quality management functions within the district and this will form part of the AQMP for FDDM, which is planned to be initiated in the last quarter of 2008.

- Research should be done into international best practice regarding controlled/prescribed burning. This is also a function for local authorities and will form part of the functions of the sub-directorate at SDM and the AQMP to be developed for FDDM.
- Regional scheduled burn areas that are published for agricultural and management fires should be done by Gauteng and Free State Provinces.
- DEAT should develop procedures for local authorities to conduct controlled / prescribed burning.
- Each local Fire Department should maintain and update a database of the locations of veld fires and the extent of the areas burnt. This should be overseen by the local authorities. At SDM, specifically Emfuleni Local Municipality, the Fire Department keeps record and this is available on request. Midvaal Local Municipality also formulates monthly and quarterly statistics from incidents in the region. At FDDM the Community, Health and Environmental Services is engaged in the Local Municipality Fire Departments and are in the process to investigate the feasibility of taking over the fire services.

5.2 Domestic Fuel Burning

Various informal settlements in the VTAPA rely heavily on low quality coal as an affordable source of household fuel (VTAPA Baseline Report, Section 4.2.1.2). The main areas of concern include Soweto, Orange Farm, Evaton, Sebokeng, Sharpville, Boipatong, Bophelong and Zamdela.

Problem: Given low level of release of domestic fuel burning appliances within the breathing space of people and sometimes even in enclosed areas, the impacts are significant resulting in poor health. The required reduction in ambient PM_{10} concentrations as a result of domestic fuel burning is between 1% and 70%. For SO_2 the concentrations from this problem complex need to reduce by up to 55% and ~3% for NO_2.

Poverty is a major contributing factor to the use of domestic fuels in households and that a cyclical relationship exists with this particular 'problem complex'. Poor ventilation, inefficient stoves, and the affordability of poor quality coal is a main concern. Continuous use of coal due to the rapid urbanisation has exacerbated backlogs in the distribution of basic services such as electricity and waste removal. In addition, various electrified households continue to use coal due particularly to its cost effectiveness for space heating purposes and its multi-functional nature (supports cooking, heating and lighting functions).

Objective: To reduce the current air pollution concentrations to acceptable levels in domestic fuel burning areas, and to make available alternative energy sources that are affordable, as well as promote the use of more energy efficient stoves.

Interventions:

Proposed ***Short-term (2008/9)*** interventions are as follows:

- DEAT together with the local authorities must implement a Vaal Triangle Area 'Clean Air Fund' to support community initiatives. The criteria, timeline and management should be agreed up front to minimise the risk of fund mismanagement, short term alternatives to Basa Njengo Magogo (BnM) should be investigated. FDDM is to start discussions with local industries to consolidate their current individual funds towards air pollution management. At SDM all funds related to clean air initiatives are handled in terms of Municipal Finance Act.
- DEAT and DME should undertake a project to investigate how to change behaviour regarding coal burning and educate people on the alternative and benefits associated with these.
- DEAT together with DME must investigate main reasons why electrified households still use other fuels. A DEAT project conducted through NOVA indicated a number of factors including appliances costs and effectiveness of coal as bulk energy carrier to serve the purpose of both cooking and heating.

- Human rights education programmes should be promoted primarily by national government (DEAT and DME).
- Rollout of safer illuminating paraffin (IP) stoves should also be initiated by DEAT and DME.
- The local authorities of SDM, FDDM and COJ together with DEAT must implement the BnM method in Sebokeng, Sharpville, Zamdela, and Soweto over the next two years. This aims to (as a minimum) reduce emissions by ~50% and safe up to 20% on coal consumption costs. DEAT has already initiated this process through the Clean Fires Campaign and the success of this will only be determined towards the end of 2009. SDM has collaborated with the Urban Environmental Program funded by Danish Government and provision is made to appoint a service provider for such a project in 2008/9. A pilot study will be done in Sharpville.

Proposed ***Short – Medium term (2012)*** interventions are as follows

- The BnM method as mentioned above should be continued over the following three years with the rollout in Orange Farm, Evaton, Bophelong, and Boipatong. The local authorities and DEAT are responsible for this initiative. This is part of DEAT's Clean Fires Campaign.
- BnM rollout to be accompanied by extensive education on the dangers/negative impacts of in-house coal burning with real death rate statistics; SDM, FDDM, COJ together with DEAT and DME are the responsible parties. Same as for the above interventions, this forms part of the DEAT Clean Fires Campaign and SDM has obtained Danish funds to start with the rollout in Sharpville. The local authorities can start with media campaigns in the local newspapers and local radio stations.
- DEAT to prioritise Vaal Triangle Priority Area air quality project support in using its social response funds. No air quality project is funded by Social Responsibility Policy and Projects (SRPP) Directorate in this financial cycle and this will be initiated in the new financial year (2009).
- Initiation of the Vaal Environmental Justice Alliance (VEJA) project on alternative energy mix for Kwa-Masiza, including:
  - Biomass: Kwa-Masiza has an old organic dump which can be used to generate natural gas;
  - Solar Energy: Kwa-Masiza has four storey buildings on which solar panels can be installed. This can supply the entire Sebokeng with affordable electricity; and,
  - Wind: Kwa-Masiza is an area within the prevailing south-westerly wind zone and suitable for the erection of wind turbines that can generate electricity for the entire Sebokeng.

  VEJA has initiated the project through a research proposal. A workshop was planned for the 15th of September 2008 at Bophelong. The evaluation of the plan will be done on a continuous basis by the Energy & Air Quality task team, the VEJA Steering Committee and the Vaal Community Assembly.
- A review must be done of the domestic fuel burning emissions inventory with updated population statistics as these become available. DEAT has appointed a service provider to compile a comprehensive emissions inventory for green house gasses. This will be reviewed once the project is completed.
- Implement an awareness raising programme through media campaigns and community forums.
- Introducing Low Smoke Fuels (LSF) (based on the assumption that a plant will be established to produce LSF in the VTAPA). DME is developing a standard for LSF together with SABS, looking to provide a less expensive LSF plant.
- Undertake a comprehensive study on health risks associated with domestic fuel burning. This should be based on hospital records and updated population statistics. DEAT is in the process of drafting project proposals to get this started.
- Identify alternative fuel sources, as fossil fuel is not an indefinite or sustainable resource.
- Investigate the feasibility of solar energy and why it is not advanced in South Africa. Eskom has experience in the form of the Shell Renewable–Eskom joint venture conducted in 1999.
- Integrate energy efficiency measures in low-cost houses; such as:
  - Housing insulation. A search for suitable and cost effective insulation materials should be done in the short term by DME together with Department of Housing and the various local authorities;
  - Electrification, and,

- Stove maintenance and replacement (start with 10% of coal burning households).

The Department of Housing has initiated studies on energy efficient designs and locations. SDM aims to bring the various housing departments at the local municipalities on board, and FDDM wants to engage with provincial and local authorities.

5.3 Iron and Steel and FerroAlloy Industrial Sector

ArcelorMittal South Africa (Vanderbijlpark and Vereeniging Works) and Davsteel (Cape Gate) are the main Iron and Steel producing facilities within the VTAPA. Samancor Meyerton (Metalloys) is the only Ferroalloy industry producing Ferro-Manganese.

Problem: Large volumes of atmospheric emissions are the main problem associated with Iron and Steel-, and Ferroalloy industries.

Activities that generate significant quantities of dust emissions include vehicle entrainment on unpaved roads, wind-blown dust from the stockpiles and material handling operations. Old technology and outdated plant designs are one of the main causes of high emissions and specifically fugitive releases.

ArcelorMittal and Samancor Metalloys were identified as the main contributing sources to PM_{10}. ArcelorMittal needs to reduce ambient PM_{10} air quality concentrations resulting from the Vanderbijlpark Works by between 1% and 21% and SO_2 concentrations by ~6.5%. NO_2 concentrations need to be verified through monitoring but the predicted concentrations indicated a required reduction of ~23%. Samancor Meyerton must reduce ambient concentrations of PM_{10} between 1% and 44%. Davsteel and ArcelorMittal Vereeniging were not flagged as main contributing sources to the ambient concentrations and therefore not required to reduce their emissions. However, the potential exists for impacts from these sources on the immediate surrounding environment.

Objective: To comply with both national emission limits and ambient air quality standards.

Interventions: Proposed interventions are provided for ArcelorMittal Vanderbijlpark and Samancor Meyerton. In addition, interventions to be implemented by government are also listed.

ArcelorMittal Vanderbijlpark has committed towards the minimisation of impacts from their operations on the receiving environment. Specific interventions in the ***short term (2008/9)*** include:

- Stoppage of dosing with spent pickling liquor at the Sinter plant: Past practices included Spent Pickling Liquor to be sprayed into the mixing drum forming potassium chloride (KCl) which form part of the gas released to atmosphere. The removal of KCl particulates downstream proved ineffective and the practice was stopped. This project was completed in May 2006 resulting in a fugitive particulate emission reduction of 5 107 tpa.
- Coke Oven Gas (COG) & Water Cleaning Plant Project: The technology was outdated and a project was initiated in 2003 to upgrade the system and reduce SO_2, NH_3 and HCN emissions. The project will be completed early in 2009. The SO_2 emission reduction is 5 686.
- Reducing roof emissions from Blast Furnace D: During the current reline of BF-D, the effectiveness of the primary extraction system was improved to capture a significant portion of the roof emissions from the cast house. It is expected that this intervention will reduce the fugitive dust emissions by 300 tpa.
- Dust suppression at waste disposal site: A dust suppression system, using high pressure to create a fine water mist, is currently being constructed at the waste disposal site to prevent dust transportation. The expected reduction in fugitive dust emissions are 70 tpa.
- Secondary Dust Extraction System at EAF: Installation of a 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 openings in the roof reducing dust emissions by 500 tpa.

- Direct Reduction (kilns) Electrostatic Precipitator (ESP) rebuild: Replaced the refractory linings that will improve the performance of the ESPs at the Direct Reduction kilns. The fugitive particulate emission reduction is expected to be 50 tpa. This will be done by November 2008.
- Accuracy of emission inventories to be updated further during 2008 by making use of additional monitoring equipment that was invested in during 2007.
- Values obtained for fugitive emissions need to be reviewed during 2008.
- VOC and S-VOC emissions should be quantified with a high level of confidence at all BU's during 2008.
- CO and CH_4 emissions need to be quantified with a high level of confidence during 2008.
- Heavy metal emissions (Cr, Ni, Pb, Zn) need to be quantified with a high level of confidence during 2008 (from point and fugitive sources).
- Dioxin and furan emissions need to be measured at all BU's during 2008.
- Potential NO_x reductions need to be investigated at all operations, especially by installing "low NO_x combustion technology". Investigations to be completed by June 2008.

Proposed ***Short – Medium term (2012)*** interventions for ArcelorMittal Vanderbijlpark are as follows:

- Replacement of old Coke Batteries: Replace Batteries 1, 3, 6 and 7 with two larger batteries (10 & 11). These batteries will be "best available techniques" (BAT) and reduce emissions from door leaks, charging and pushing of coke. Batteries V4, V8 and V9 will continue to operate until 2020. Fugitive particulate emission reduction expected to be 772 tpa (subject to further investigation).
- Sinter Clean Gas Unit: Installation of emission abatement technology (bag filter system) to reduce particulate emissions from the entire Sinter Plant. The addition of lime to the off-gas will be introduced to effectively remove SO_2. Emission reduction expected is 1 848 tpa for particulates. The SO_2 reduction needs to be confirmed.
- Replacement of old Coke Batteries: Replace Batteries 1, 3, 6 and 7 with two larger batteries (10 & 11). These batteries will be informed by "best available techniques" (BAT) and reduce emissions from the combustion stacks. Batteries V4, V8 and V9 will continue to operate until 2020. Particulate emissions will reduce by 318 tpa and SO_2 by 1 712 tpa. The project will be completed by December 2013.

Samancor Meyerton has indicated their commitment to improve operations in order to reduce the ambient PM_{10} concentrations resulting from their plant. A number of options have been investigated, with some mutually exclusive and the most feasible and viable strategies will be investigated further for implementation. Metalloys will however ensure that the selected strategies conform to the requirements of the VTAPA AQMP.

Specific ***short-term (2008/9)*** interventions and strategies that have been investigated include:

- Rehabilitation of old North dams: The project is aimed at rehabilitating the area west of Metalloys office building where decommissioned old North plant sludge dams are situated. The project is intended to be considered during integrated rehabilitation planning in 2008/9 with the aim to finally green the area.
- Dust suppression at Final Products Handling: Dust suppression by added moisture, screening and washing to remove fine materials, resulting less dust generation during dispatching. The project was completed in 2008.
- Rail tippler building enclosure at Raw Materials Handling: During the windy periods, the wind blows the dust out of the semi open structure. The enclosed Rail Tippler building will contain the dust and ensure that the existing wet dust suppression system works more effectively. This was completed in 2008.
- 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. This project was delayed due to amendment of the scope and will be completed by the end of 2010.
- Dust-A-Site network extension: Construction of a road and weekly maintenance of 150m of the current dirt road next to the salvage yard with dust-a-site. This project was completed in October 2007.

- A comprehensive Air Quality Management Plan and Emission Reduction Strategy (ERS) development and facilitation conducted in 2008. The ERS focussed on particulate emission with the results presented to DEAT as part of Metalloys commitment to reduce impacts in the VTAPA. The main findings were:
    - o West Plant ERS will result in emission reduction of between 50% and 99% and predicted ground level concentration reductions (at the plant boundary) of between 50% and 99%.
    - o ERS at the South Plant will result in emissions reductions of between 16% and 89% with off-site impact reductions predicted to range between 49% and 100%.
    - o At the North Plant, planned ERS include emission reductions of 70% and 1005 with predicted reductions in concentrations of 51% and 100%.
    - o Material management mitigation scenarios will result in emission reductions of between 50% and 100%. Predicted ground level PM_{10} concentrations will reduce by between 26% and 100%.

  An additional 15 projects have been identified and included in the ERS process. However, for these projects the emission reduction could not easily be quantified and was therefore not included even though some of these have already been implemented i.e. extensive greening of previous open areas.

Mechanisms implemented to inform the emission reduction strategy and track future progress include:

- Installation of continuous ambient air PM_{10} monitoring on site and in downwind communities, including meteorological data. This was completed in August 2007.
- Extensive data collection of all point, fugitive, area and line sources of relevant pollutants during APPA permit review. This was also used to compile a comprehensive emissions inventory. This was completed in October 2007.
- Short-term ambient air PM_{10} monitoring project to assist in emission source identification – done in February 2008.
- Dispersion modelling of current baseline conducted in March 2008, thus completed.
- Continuous online point source emission monitoring phase 1 of particulate matter to be done in 2008.

Aside from the emission, reduction strategies and interventions provided by the individual industries, there are a number of recommended interventions applicable to emission problem complexes in general to be driven by government. The interventions are provided under Section 5.10 for 'Government Capacity for Air Quality Management'.

5.4 Mining Operations

The main mining operations within the VTAPA include the New Vaal Colliery, Sigma Colliery and Glen Douglas Dolomite Mine. In addition, there are numerous small mining and quarry operations that have not been identified during the baseline assessment for the VTAPA. Sigma's opencast mining operation, Wonderwater, is in the decommissioning and closure phase.

Problem: Large volumes of pollution generated typically in the form of fugitive releases.

The main problem of opencast mining operations, as is the case of all three the mines located in the Vaal Triangle Airshed Priority Area, is the generation of excessive dust emissions. Gaseous emissions are also a problem but to a lesser extent.

Objective: To minimise both fugitive dust and gaseous emissions from mining operations through the implementation of mitigation measures at the main sources of emissions (i.e. materials handling operations, crushing and screening, chemically treated haul roads, control of wind erosion etc.)

Interventions: were only provided by New Vaal Colliery over the ***short term (2008/9)***. These are as follows:

- Operation of a dust fallout monitoring programme: The dust fallout monitoring network will be expanded to include 32 single and nine directional dust bucket monitoring network. This was initiated in 2008 and is an ongoing intervention.

- Implementation of dust suppression technologies including three water tankers running 24 hours per day spraying the haul roads. Also, the use of water sprays at plant conveyor belt transfer points, and spraying and compaction of seasonal coal stockpiles will be investigated. The use of fogging cannon at tip and/or stacker/reclaimers and the use of (up to) five water cannons at working faces are ongoing.
- Dust-a-side application on haul roads: Currently 8km is covered and a total of 13.8km is planned for 2008.
- Enclosure of the primary tip and installation of a passive dust stilling hood is 85% complete. The upgrade of sprays and installation of a conveyor belt curtain is still to be completed.
- A dust hood was installed at the secondary crushers. The motor damper arrangement is to be finalised.
- The implementation of a buffer blasting programme to minimise ingress of air into old workings is ongoing standard operating procedure.

Performance indicators initiated to track performance include:

- An air emissions inventory has been developed for the mine but need to be updated to reflect the current operational status. This was also initiated in 2008 and will be ongoing.
- A gravimetric dust sampling programme, using random statistically representative number of employees to collate data, is an ongoing standard operating procedure. A quarterly report is submitted to the inspector.
- 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. This will be completed in 2008.

Recommended interventions from the government sectors that are applicable specifically to mining are provided. The ***short-term (2008/9)*** interventions are as follows:

- Detailed emission reduction strategies to ensure compliance with ambient air quality standards to be submitted to DEAT by New Vaal, Sigma, and Glen Douglas. DME is responsible to ensure local authorities are represented in the inter-departmental committee. FDDM is a member of Regional Mining Development & Environmental Committee, Free State Department Minerals & Energy. SDM is to establish an Air Quality Management (AQM) sub-directorate to coordinate all air quality projects.
- Representation of local authorities on the inter-departmental committee tasked with the regulation of mining activities. This is the responsibility of all the local authorities, DEAT and DME.
- The local authorities together with DME are to ensure all mining operations within the VTAPA have approved EMPRs (specifically smaller mining and quarry operations). FDDM has a target date of December 2008 and the AQM sub-directorate at SDM to be established will coordinate all mining activities.
- DME and the local authorities to identify and quantify emissions from all smaller mining and quarry operations not included in the VTAPA AQMP and update the VTAPA emissions inventory.
- Annual roadworthy checks for all mine export vehicles to be done by the local authorities and provincial governments.
- Regular internal and external audits to be conducted (external by independent party) and reported to the District Municipalities. This is the responsibility of the provincial government and local authorities. FDDM proposed assistance to be supplied by DME.
- Implement priority area emissions trading system i.e. fund other projects other than own emission reduction that will result in an overall decline in emissions. It is recommended that industry provide DEAT with a written proposal.

5.5 Petrochemical Sector

Sasol Chemical Industries (SCI) and Natref are two chemical production facilities located in the VTAPA in the Sasolburg area. Omnia Fertilisers was also grouped with this sector.

Problem: Gaseous and particulate emissions from the petrochemical industry influence the air quality within the VTAPA.

Particulate emissions are associated with dust emissions from the waste dumps and stockpiles, as well as the combustion process, which generates both particulate and gaseous emissions. Gaseous emissions, in particular SO_2 emissions, have also been identified during the Baseline Assessment to be of concern. This can be due to outdated and ineffective technologies.

Sasol is required to reduce ambient concentrations of NO_2 by ~18% and SO_2 concentrations by ~7%. Natref needs to reduce SO_2 concentrations by between 1% and 5% whereas Omnia is required to reduce PM_{10} concentrations by ~2.5%.

Objective: To achieve acceptable pollutant emissions through best practice management techniques to ensure the minimisation of fugitive emissions from the waste dumps and stockpiles and emission reduction from the combustion process to be informed by Best Available Techniques (BAT).

Interventions proposed by Sasol, Natref and Omnia are discussed below.

Sasol's proposed ***short-term (2008/9)*** interventions are as follows:

- Sasol Infrachem, a division of Sasol Chemicals Industries (Pty) Ltd, has identified three main SO_2 sources from its operations in Sasolburg. The smallest of the three sources will be reduced by 10% but this will not meet the overall required reduction of 7%.
- Emission off-setting: Sasol will increase their SO_2 and NO_x emissions over the short-term by re-commissioning the old boilers for electricity generation. Particulate emissions will be removed by optimising the current ESPs but SO_2 and NO_x will not be controlled resulting in an overall increase in PM_{10}, SO_2 and NO_x emissions. Sasol will off-set these increases in emissions by implementing further Basa Njengo Magogo fire making methods in Zamdela and surrounding areas.
- Sasol will investigate reduction options for the steam producing facilities (the larger sources). There are three options, namely:
    - Retrofit a number of boilers on both steam station units as to reduce SO_2 and NO_x emissions. This will result in SO_2 and NO_x compliance within 7 – 10 years.
    - Some of the steam station equipment is more than 55 years old and nearing the end of its useful lifetime. Thus, the option is to decommission the oldest equipment and rebuild it on a modular approach. This will result in a significant reduction in emissions but will take 6-8 years.
    - Building of a new unit replacing the existing two steam stations. This will result in a significant reduction in emissions but will take 10 – 20 years.

The National Petroleum Refiners of South Africa (Natref) has an approved Environmental Improvement Plan mutually agreed with DEAT and NGO's in 2002. The improvements agreed upon as well as projections towards 2009 and indicative 2015 improvements are reflected below. This is applicable to both Natref and Sasol.

Short-term (2008/9) interventions:

- Alternatives to flaring e.g. re-use for internal processes.
- Establishment of corporate minimum requirements on Environment/Health/Safety.
- Establishment of community outreach programmes and open days (information sharing).
- Corporate directive on continuous flaring.
- Reduction of fugitive HCs from oil separation basins.
- Reduction of fugitive VOC emissions from process leaks (leak detection programme).

These interventions should ensure emissions reductions of 16% for SO_2, 9% for NO_2 and 1% for VOCs. In addition, approximately 80% reduction in SO_2 emissions should be realised at the end-point user, i.e. mobile sources due to the agreed interventions.

Omnia has installed emissions monitoring and control systems at its various production units at the Sasolburg site and is also investigating others. Air emission reduction systems have also been installed and optimisation plans to improve their effectiveness are currently underway.

The ***short-term (2008/9)*** interventions include:

- Although not required in terms of the proposed VTAPA management plan, Omnia is committed to reduce its NO_x emissions by at least 80% from the 2007 emission loads through the installation of appropriate abatement technology.
- Installation of online monitoring equipment at the nitric acid plant.
- Reduction of fugitive dust emissions in certain areas of the granulation plants through the systematic implementation of improvement practices.
- Reduction in the fluoride emissions through the installation of improved scrubbing technology at the Superphosphate plat.
- Installation of monitoring equipment on the granulation plants to improve the measurement and management of dust emissions.

The ***medium – long-term (2012)*** interventions include:

- Roll out of improvement practices to other areas within the granulation plants to further reduce dust emissions.
- Evaluate Granulation Plant 2 stack emissions and investigate best practical environmental option.
- Evaluate best practical environmental options for material loading and offloading activities.
- Promote increased awareness amongst employees and communities through targeted initiatives and awareness campaigns.

These interventions should ensure a reduction of 2.5% in PM_{10} emissions compared to 2007 emissions, as required.

Additional emission reduction interventions to be implemented by government at the Petrochemical industry sector in the ***short – medium (2012)*** term include:

- DEAT and the District Municipalities to investigating the funding of Basa Njengo Magogo rollout in Zamdela by Sasol, Natref and Omnia. Sasol is already funding the rollout in Zamdela.
- The petrochemical industries should measure for VOCs, PM_{10}, $PM_{2.5}$, and O_3 (also consider secondary pollutants). DEAT is the responsible party.
- More stringent fuel specifications could result in more production of emissions (SO_2, NO_2 and CO). This is primarily dependent on vehicle emission standards to be proposed by DEAT.
- Petrochemical industries to comply beyond ambient standards to allow for (i) further expansion, (ii) upset conditions and (iii) failures in reduction strategies.

5.6 Power Generation

Lethabo power station is the only power generating source within the VTAPA.

Problem: Use of low grade coal in coal-fired power stations requires large quantities of coal being used as fuel source and therefore results in gaseous and particulate emissions. Sources of fugitive emissions include the coal stockpiles and ash disposal dumps.

Lethabo Power Station is designed to burn low grade coal and is fitted with Electrostatic Precipitators (ESP) and a Flue Gas Conditioning plant to reduce fine particulates. Even so, the power station is operating above design capacity resulting in more frequent upset conditions (releasing uncontrolled emissions to air), affecting the ambient concentrations. Lethabo is also one of the main contributing sources to SO_2 ground level concentrations and should reduce by up to ~58%. This is primarily due to no desulphurisation currently in place. In addition, significant quantities of dust are generated as a result of wind-blown dust from the coal stockpiles, active and unrehabilitated ash disposal dumps. Dust is also generated as a result of materials handling operations and vehicle entrained dust from roads.

Objective: To reduce emissions to acceptable concentrations i.e. below the ambient air quality targets where health impacts are minimised.

Proposed ***interventions*** over the ***short term (2008/9)*** are provided below.

- ESP transformer upgrade: As the transformers fail, they will be replaced. There is a current stock of six upgraded spares. This will ensure or increase the reliability and availability of the ESP fields. This is an ongoing project.
- Installation of the ESP Plant Management System is complete and will optimise the operation of the ESPs to reduce emissions and allow better management of the rapping procedure. Installation of the load cells in Unit 5 is completed.
- SO_3 distribution lance upgrade is to prevent the blockage of the nozzles in order to ensure proper distribution of SO_3, and will thus improve the efficiency of the ESP. This has been completed.
- Replacement of the MCS1 with MCS2 to allow better control of the ESP fields, and ensure that spares are available. This is also completed.
- Replacement of the secondary air heater element packs - Unit 1 is outstanding in the current maintenance cycle. This will be conducted every six years until the end of station life.
- On-line stack monitoring: Continuous emissions monitoring system to measure SO_2, NO_x, CO and O_2 in the flue gas will be installed in Unit 1. This will allow compliance monitoring with the conditions in the emissions license.
- Ambient monitoring station: An ambient monitoring station measuring SO_2, NO_2, and PM_{10} will be established at Refengkgotso ~ 20km southeast of Lethabo. Air Quality reports detailing the findings of the monitoring at the Refengkgotso monitoring station will be compiled on a quarterly basis and submitted to DEAT.
- A network will be established to monitor fugitive emissions (PM_{10}) from the ash dump at Lethabo. It will initially include two monitoring stations and will be expanded if needed.
- Communication channel for upset conditions has been established. Complaints about emissions from Lethabo are received and addressed by the environmental practitioners at the station. This is primarily regarding start-ups and upset conditions. Notification of upsets is send to DEAT, SDM, Metsimaholo Municipality, Sasol Infrachem and a Three Rivers community representative.
- SO_2 emission reduction: A comprehensive study by Eskom into retrofitting the power station with FGD proved not feasible or economically viable. An investigation is currently underway to assess the feasibility of coal beneficiation with respect to sulphur removal. If this is feasible, steps will be taken to implement it.
- Energy efficiency measures: Extend energy supplies and reducing greenhouse gas emissions. Lethabo initiated a lighting programme to further improve energy at the power station, resulting in a saving of 735 MWh a year.
- Offset projects: Eskom was involved in the "Winter Clean Fires Campaign 2008" together with Sasol on the Basa Njengo Magogo activities in the Vaal Triangle Area. Eskom is also using the Eskom Energy and Sustainability Programme for education and awareness creation.
- Electrification programme: Eskom's electrification projects scheduled for the Vaal Triangle include Emfuleni (Tshepiso N ext 1 – 295 households), COJ (Nomzamo – 470 households).

- Upgrading of the sprinkler system for more effective irrigation of Lethabo's ash dump in order to suppress windblown dust emissions.

Additional ***short-medium term (2012)*** interventions to be implemented by government on the power generation sector include:

- South African Mercury Assessment: An international study on Mercury Assessment is being conducted and will be facilitated and hosted by DEAT when finished.
- Use of billboards to raise awareness around the impact of good air quality management DEAT is doing this as part of the Clean Fires Campaign and Eskom is also involved.
- Investigate the feasibility of solar energy and why it is not advanced in South Africa. Eskom has experience in the form of the Shell Renewable–Eskom joint venture conducted in 1999. This should further be investigated by Eskom in partnership with DEAT and DME.
- Electrification of low cost houses as included in Eskom's interventions. DEAT and DME to also be involved in the project.
- DME to develop and enforce stricter regulations for start up emissions/cleaner technologies.
- DME to develop regulations on the restriction of export of high quality coal.
- DEAT should not allow any new power stations in the stressed area until such time as the ambient concentrations are within compliance with the VTAPA AQ Targets. This can be based on the EIA regulations falling under the Chief Directorate: Environmental Impact Management.

5.7 Small Industries

Various fuel burning appliances, including boilers at schools and hospitals, pizza ovens, stand-by generators, air heaters, (etc.) are located within the VTAPA.

Problem: Emissions are often uncontrolled and unregulated and these sources generally have low stack heights resulting in poor dispersion potential. Pollutants released from these sources tend to have a localised impact.

With the previous absence of legislation and regulations to effectively manage emissions from small industrial operations, the impact of these sources on the ambient air quality is largely un-quantified. Few databases exist of these sources in the region, and where available, these databases are outdated or incomplete.

Objective: To achieve acceptable local air quality in close proximity to these sources.

Proposed ***interventions*** are provided in below for the ***short – medium term (2012)***:

- Electronic database of all small industries to be compiled by Municipalities. The AQM sub-directorate at SDM will coordinate this function to be undertaken by the local authorities and compile this into one database at district municipality level. FDDM has set the target date for initiating this process as December 2008.
- DEAT should develop a permit system for all non-listed activities.
- Company orientated community initiatives should be steered by the District and Metropolitan municipalities. FDDM is to engage with small industries in future.
- Model scheduled trade by-laws. This is the responsibility of the District and Metropolitan municipalities. The AQM sub-directorate at SDM will coordinate development of by-laws. FDDM will draft air quality by-laws in 2009/2010.
- DEAT to declare small boilers controlled emitters. There is a proposal on the requirements for small boilers in the current standard setting process and is expected to be gazetted by the end of 2008.

5.8 Transportation

Air pollution from vehicle emissions may be grouped into primary and secondary pollutants. Primary pollutants are those emitted directly into the atmosphere, and secondary, those pollutants formed in the atmosphere as a result of chemical reactions, such as hydrolysis, oxidation, or photochemical reactions.

Problem: Although vehicles were not identified to be a major source in the VTAPA, the potential exists for emissions from vehicles to significantly contribute to the ambient air quality within the future years

An inefficient and unreliable public transport system has resulted in an increasing number of privately owned vehicles within the region, including an increase in use of taxis as the main mode of public transport. Insufficient infrastructure exists due to poor town planning resulting in traffic congestion in many areas. The proliferation of heavy vehicles on the local road network to transport heavy/bulk materials has also led to traffic problems in the region.

Objective: To reduce emissions from vehicles through improvements in the vehicle fleet and measures to reduce petrol and diesel emissions, an efficient and reliable public transport system, taxis to become an optional mode of transport, improved and informed town planning (specifically for future transport developments) and reduce the number of heavy vehicles on the roads by improving the rail network.

Short-term (2008/9) interventions proposed:

- Synchronisation of traffic lights to promote the flow of traffic to be initiated by local authorities. FDDM recommends the form of partnerships with local and provincial traffic departments. SDM to engage and coordinate with local municipalities who should form partnerships with traffic departments.
- The DME Taxi recapitalisation programme.
- Integrate all stakeholders in road construction and planning e.g. taxi associations (SDM, FDDM, and COJ). FDDM is to form a transportation sector forum and SDM proposed liaising with taxi organisations during public meetings.
- District and metropolitan municipalities to tar or cement roads. FDDM recommend the forming of partnerships with local and provincial road networks. SDM links with ongoing projects from local municipalities.
- Vehicle emission blitz in partnership with the City of Cape Town - district and metropolitan municipalities. FDDM is to procure a Hartridge meter in 2009/10. SDM to engage and coordinate with local municipalities.
- Review vehicle emissions database with updated traffic count data as these become available. FDDM to form partnerships with local and provincial traffic departments and SDM to engage and coordinate with local municipalities and develop central database.
- Roadworthy certification to ensure vehicles is maintained by local government.

Short – medium term (2012) interventions include:

- Improvement of fuel quality (reduction of sulphur in petrol to 50 ppm) is to be driven by DME and it is recommended to bring the Department of Transport onboard.
- DME to stipulate new technology for vehicles.
- Heavy trucks to use alternative routes and not pass through Cities and Towns. This should be regulated by the metropolitan and district municipalities. FDDM to form partnerships with local and provincial traffic departments.
- Regulation of diesel driven vehicles: DEAT future Emitters project, Norms and Standards Project will develop regulations but will not affect the on-road vehicle fleet, thus local authorities are expected, through by-laws, to establish control measures for on-road vehicles.
- Vehicles to be declared controlled emitters: DEAT's future Emitters project, Norms and Standards Project will only effects new vehicles and not on-road fleet.

- Introduction of a vehicle monitoring programme to be done by the district and metropolitan municipalities. FDDM is to procure a Hartridge meter in 2009/10 and SDM to engage and coordinate with local municipalities.

Medium – long-term ***(2017)*** interventions include:

- Transnet must be called to task to address the rail network and improve it as an alternative to road transportation. This is the responsibility of the Department of Transport and Transnet.
- Update emissions inventory with airport and railway information as it becomes available or when it becomes a significant source. This will be the responsibility of the local authorities.

5.9 Waste Burning

Problem: Heavy metal, dioxin and furan emissions from waste incineration represent a considerable air quality and health risk concern related to such operations.

Particulate emissions from incinerators may comprise heavy metals such as chromium and cadmium, which are suspected human carcinogens. Emissions from waste incineration processes are directly related the type and amounts of waste. Ineffective and inconsistent municipal waste collection services in many informal areas promote the burning of domestic waste.

Objective: To have acceptable emissions from waste burning and to minimise emissions from uncontrolled burning in landfill site.

Proposed ***short-term (2008/9) interventions*** are as follows:

- Introduction of tyre regulations by DEAT. The Chief Directorate: Pollution & Waste Management – Waste Stream Management has drafted a Waste Tyre regulation, which is not yet in force.
- Develop National legislation for dioxin control. This will form part of the Emissions Standards document to be gazetted in March 2009. In addition, DEAT's Chief Directorate: Pollution & Waste Management – Waste Stream Management is currently looking at emissions limits for incinerators and for cement kilns co-processing hazardous waste.
- Develop an emissions inventory of waste burning sources (incinerators, sewage and waste water treatment works, etc.). SDM's AQM sub-directorate is to coordinate the process. FDDM has set a target of December 2008.
- Incineration policy. DEAT's Chief Directorate: Pollution & Waste Management – Waste Stream Management is currently looking at emissions limits for incinerators.
- Landfill permitting backlog project by DEAT.
- Use music, art, poetry and drama to disseminate information. – DEAT together with local authorities. This forms part of DEAT's Winter Clean Fires Campaign. SDM's AQM sub-directorate to coordinate and FDDM to form partnerships with arts activists.

Short – medium term (2012) interventions are as follows:

- Undertake a comprehensive study on the impact of dioxins. DEAT's Chief Directorate: Pollution & Waste Management – Waste Stream Management is currently looking at dioxin emissions limits for the country using the internationally accepted "Dioxin Toolkit" developed through UNEP. This will give an estimate of the total dioxin emissions in the country and will identify priority areas.
- Proper refuse removal by local authorities (SDM, FDDM, COJ). FDDM has completed an Integrated Waste Management Plan (IWMP). SDM will coordinate it through their Local Municipalities.
- Local authorities to create awareness around recycling. SDM's AQM sub-directorate is to coordinate. FDDM's completed IWMP identified projects to be implemented.
- Vaal Environmental Justice Alliance (VEJA) - DEAT school programme.

Proposed ***medium - long-term (2017) interventions***:

- Use energy from waste burning to generate electricity - DEAT and DME.

5.10 Government Capacity for Air Quality Management

The capacity in government pertains to all spheres of government including National, Provincial and Local Authorities. The government bodies directly involved in air quality management in the VTAPA include DEAT, Gauteng Province (in the form of GDACE), Free State Government, Sedibeng District Municipality and Fezile Dabi District Municipality.

Problem: Lack of capacity in terms of resources, tools and finances for air quality management and control in all spheres of government.

With the introduction of AQA, air quality management responsibilities are transferred to Local Government. However, Local Municipalities currently have limited capacity for air quality management and control and as a result, air quality management is not prioritised. Additionally, air quality functions often form part of other environmental related functions, which limits the effectiveness of air quality management in the region. As a result, air quality management and control is addressed in an adhoc manner, which limits its effectiveness.

Objective: To ensure that emissions from pollution sources are controlled through good governance at a National, Provincial and Local Level through the prioritisation of air quality issues in Government, finances and resources to be made available and capacity building in air quality management.

Proposed ***interventions*** in the ***short term:***

- Development of an implementation manual for the VTAPA AQMP to be distributed to the relevant local authorities. This will be completed in September 2008.
- Publication of National Ambient Air Quality Standars with allowable frequency of exceedances and implementation timelines. DEAT has drafted Section 9 notice, which was approved by the Minister. The draft is currently under discussion at the SABS and is likely to be gazetted for public comment in February 2009.
- Listed activities and related emission standards must be published by DEAT. The draft minimum emission standards are finalised and submitted to SABS for further technical assessment. The standards will be finalised by January 2009 and gazetted for public comment by March 2009. The emissions standards, including emissions monitoring and reporting requirements will come into effect 11 September 2009.
- Emission monitoring, as specified in the National Framework must be established by DEAT. Emissions monitoring and reporting requirements will be gazetted as part of Section 21 notice and will come into effect 11 September 2009.
- National Framework Review and Publication of the National Framework by DEAT. This will be done by 11 September 2009.
- Review of current APPA Registration Certificates and conforming into new revised RCs and eventually AELs by DEAT. This project will be completed by end 2008.
- The local authorities and DEAT will develop government/community/industry liaison committees. DEAT recommends that the existing MSRG/AQOF as established during the VTAPA AQMP project be used.
- Regulations on fee calculator to be used in calculating the prescribed processing fee for atmospheric emission licenses by DEAT as part of the APPA RC Review project. The regulations will be drafted as soon as the fee calculator has been completed in October 2008.
- DEAT is to develop an atmospheric user charge concept. This will be done once the license fee calculator has been completed.
- Companies Social Responsibility programme. This pertains to all the industries within VTAPA.
- Enforcement and compliance by the Green Scorpions.
- Marketing of the priority area by DEAT.

- A standardised air quality dispersion model to be identified as part of the National Framework and housed by DEAT.
- Development of detailed action plans for all interventions as stipulated in the VTAPA AQMP to be incorporated into the revised AQMP. DEAT, together with provincial governments (GP & FSP) and the local authorities (SDM, FDDM & COJ). SDM has appointed consultants to identify and assess the resources and operational system requirements for the delivery of an effective air quality management service.
- Review and update of VTAPA AQMP to include the detailed emission reduction strategies provided by industry and government - DEAT together with provincial governments (GP & FSP) and the local authorities (SDM, FDDM & COJ). This should be incorporated into the central District Municipality database.
- Establishment of a separate, dedicated air quality division within each level of Government whose specific functions are related to air quality management and control. SDM is in the process of establishing such as section with capacity building in progress. FDDM restructuring was approved in 2007 and the Coordinator: Municipal Health Services, Auxiliary services will deal with environmental pollution, including air pollution.
- Each sphere of Government to appoint a skilled, trained air quality officer (AQO) FDDM designation to be finalised by June 2008 and SDM is still within the structural phase.
- Air Quality Management courses to be held in collaboration with each Municipality and Province. Responsible parties are: DEAT, GP, FSP, SDM, FDDM & COJ. SDM and GDACE have successfully completed the NACA/University of Johannesburg Air Quality Management Course. FDDM attended all courses/workshops organised by DEAT.
- Regulations for the management of ozone depleting substances. DEAT is awaiting the completion of the functional analysis.
- Emphasize prevention and improvement, not correction (DEAT).
- Generic by-law development and modelling. A draft has been developed by DEAT.
- Regulations in respect of the 'prescribed form' for atmospheric impact reports should be provided by DEAT.
- Institutional reform at Local Government Level – establishment of structure. This should be done by the district and local municipalities.
- Setting up of the 'Emission Licensing Authority' in Sedibeng District. SDM is in negotiations with DEAT to get the authority to issue APPA Registration Certificates.
- Encouragement of the planting of trees. This is an on-going process at FDDM and SDM in collaboration with the local municipalities as well as the Gauteng and Free State provinces.

Short – medium term (2012) interventions:

- Expand, upgrade and improve the first level emissions inventory developed for the VTAPA and to be housed by DEAT (within the short – medium term) in collaboration with SDM, FDDM & COJ.
- Comprehensive health risk assessment to be conducted for the VTAPA based on hospitalisation records and updated population statistics. DEAT and local authorities.
- Air quality directives to be established in the priority regions by the district and local authorities.
- Quarterly reporting to Councils on air quality in the area by the district and metropolitan municipalities.
- Improvement projects not to be delayed by full EIA processes and waiting for Record of Decisions (RODs). Provincial government (Gauteng and Free State).
- Installation of additional monitoring stations by the local authorities, mainly SDM, FDDM and COJ. SDM has re-commissioned one Opsis station in Emfuleni Local Municipality. This will form part of the air quality management plan process to start in last quarter of 2008 at FDDM.
- Ensure all air quality monitoring stations are SANAS accredited as stipulated by DEAT. All the current ambient monitoring stations are in the process of being accredited.
- Institutional restructuring at provincial level to create a unit that specialises in air quality functions only (Gauteng and Free State).

- VEJA councillors programme to be done in cooperation with SDM, FDDM & COJ.
- Widespread public awareness and education to mobilise people so that air quality issues become prioritised by politicians (DEAT, GP, FSP, SDM, FDDM & COJ). Local Municipalities should continue ongoing educational programmes and include air quality related issues.
- Develop ways of informing politicians (e.g. PCF), and raising awareness by DEAT and the local authorities. Air quality is a standing item in the Portfolio and Mayoral committees' meetings at FDDM. SDM has information sharing sessions with politicians and through Section 80 meetings.

5.11 Information Management

Problem: The availability and dissemination of air quality information is a major obstacle affecting air quality management and control.

Very little historic air quality monitoring data is available in the region, with air quality monitoring previously undertaken by the industries in the region. In addition, current monitoring practices are not standardised and as a result, information is often scattered and fragmented and insufficient data is collected and collated, with data not routinely transferred into information.

Objective: To ensure that information is readily available to stakeholders through sufficient data collection, collation and dissemination. Prioritisation of ambient air quality monitoring (comprehensive monitoring network) and the standardisation of monitoring practices and ensure SANAS accreditation.

Proposed ***interventions*** are provided below for the ***short term (2008/9)***:

- DEAT should publish a quarterly AAQ progress report on the National website and email to stakeholders. This will eventually form part of SAAQIS.
- A centralised, electronic complaint register database should be developed at all municipalities. Both SDM and FDDM are in the process of developing a central electronic complaints register.
- DEAT should conduct a comprehensive survey on the impact of air quality information/products by all stakeholders.
- Source apportionment by chemical mass balance at three sites (led by DEAT and Eskom to support).
- An epidemiological study should be initiated to establish baselines to allow the track of improvements between current and future improved trends. This should be led by DEAT with Eskom and other industries and local authorities as partners.
- Comprehensive emissions inventory compiled and regularly updated as part of SAAQIS. DEAT has appointed a service provider for compiling a comprehensive emission inventory for the green house gasses. This will be incorporated into SAAQIS once hand over to DEAT at finalisation of project. The South African Weather Services should also be involved to provide standardised meteorological datasets.
- Develop a 'Did You Know' website of air quality information/data. This should include positive issues e.g. reduction of emissions etc setting up of communication system i.e. complaints with industry. This should be done by DEAT together with local academic institutions.
- Wall newspapers (DEAT).
- Community Information Strategy by VTAPA MSRG & AQOF. This should be an ongoing process.
- Publish information on who's who in the air quality management industry in the area. This can be published on the National website. DEAT has developed regulations relating to information management with regard to atmospheric emission licences and will form part of the regulations as soon as APPA is repealed.
- Sedibeng to have two operational air quality monitoring stations. Feed data into the data management system at SDM.

Short – medium term interventions:

- SANAS accredited monitoring methodologies and standard QA/QC. This will be done through DEAT's SAAQIS project.
- Public access to all emission inventories. This will be through SAAQIS.
- Environmental literacy programme for learners and educators to be initiated by DEAT.
- Develop booklet of FAQ with responses from DEAT (to be updated regularly).
- All monitoring stations to have meteorological equipment and to be SANAS accredited (SDM, FDDM & COJ).
- VEJA to feed back to all affiliates and collaborate with SDM, FDDM & COJ.
- Development of an electronic, centralised air quality monitoring database. This will be developed as part of the South African Air Quality Information System (SAAQIS). The SAWS should also be involved.
- National upper-air meteorological network should be established by DEAT and the SAWS.

6. AIR QUALITY MANAGEMENT PLAN IMPLEMENTATION STRATEGY

An AQMP cannot be successfully implemented and revised in the absence of an effective air quality management system. Essential tools in an air quality management system include an emissions inventory, dispersion modelling, source and ambient air quality monitoring. Capacity, in terms of resources and finances, within the VTAPA needs to be developed to ensure the effective implementation of the AQMP.

6.1 Ambient Air Quality Monitoring

An ambient air quality management system consists of various hardware, software, communication systems as well as activities related to the ongoing maintenance and calibration of the system. Continuous ambient air quality monitoring requires among others, a set of trace gas analysers housed in a secure shelter, meteorological equipment, a data communication and acquisition system, as well as various other mechanical, civil and electrical structures such as an inlet manifold, fencing, concrete plinth, air conditioner, Uninterrupted Power Supply (UPS) and safety devices such as a lightning conductor. The monitoring equipment must be maintained and calibrated on a regular basis.

The objectives for implementing a monitoring network will determine the pollutants to be monitored and the frequency and duration of monitoring required. Subsequently this will inform the type of equipment to be installed. Objectives for monitoring is typically to determine the status quo of the air quality in the region, or to determine compliance with ambient air quality objectives, to provide trend analysis or to track progress due to the implementation of mitigation measures, to demonstrate continuous improvement or to use as dispersion model validation. Examples of monitoring equipment have been included in the AQMP for the VTAPA.

In addition, vehicle monitoring, in particular diesel smoke testing, is an effective method to determine if vehicle emissions are acceptable. Traditionally, testing of diesel vehicle emissions has been undertaken using a Hartridge smoke meter in accordance with the requirements of APPA. Diesel vehicle testing can also be undertaken using the mobile Smoke Check 1667 instrument. An important criterion is that the instrument should be able to measure smoke from turbocharged diesel-driven vehicles.

6.2 Ambient Air Quality Management

6.2.1 Emissions Inventory

A first requirement for effective air quality management and control is the establishment of a comprehensive, accurate and electronic emissions inventory of all identified sources. An emissions inventory includes information on source parameters and associated pollutant emission rates. As part of the baseline assessment undertaken for the VTAPA AQMP, a first level emissions inventory has been established. It was recommended that this emissions inventory be updated and expanded to include all the sources of emissions. All sources of

atmospheric emissions should be identified and quantified, including point and non-point sources. In order to assist in the data collection phase it was recommended that use be made of the tertiary institutions within the VTAPA. Students can do field work in identifying additional sources of emissions, collecting information from the outstanding sources and be used for traffic counts to update the vehicle emissions database. It is however important that the emissions inventory development be done by DEAT and the skills developed in house in order to transfer these skills to the local government sector. The eventual goal is to incorporate this emissions inventory into the SAAQIS to form part of a central database.

6.2.2 Dispersion Modelling

Atmospheric dispersion modelling forms an integral component of air quality management and planning. Dispersion models calculate ambient air concentrations primarily as functions of source configurations, emission strengths, terrain features, and meteorological characteristics. The CALMET/CALPUFF suite of models was used in the baseline assessment and it was recommended that this model be used in future reviews of the VTAPA AQMP in the short to medium term. A dispersion modeller should be appointed to manage, update and run the model. The model results should be linked to the GIS System and the information made available to the public. This should also eventually be incorporated into the SAAQIS system.

6.3 Human Resources

For this AQMP to be effective, co-operative governance and political buy-in across all spheres of government will be required, as well as the capacity to enforce compliance with the new legislation. It is recognised that air quality management and control is primarily a function of the Local Municipalities with emission licensing functions undertaken by District and Metropolitan Municipalities. In order to increase the capacity in Local Government, authorities need to invest both time and capital. For Municipalities to fulfil their regulatory role in terms of air quality, dedicated personnel need to be appointed. As required by current legislation, Air Quality Officers must be appointed within National, Provincial and Local Government. Requirements and responsibilities for the various positions regarded essential in air quality management were provided.

6.4 AQMP Review Requirements

The Final AQMP will be published in the Government Gazette for public comment once it has been approved by the Minister.

The VTAPA AQMP will be revised within 2 years, following which it will be revised every 5 years unless otherwise required by DEAT.

As part of the VTAPA AQMP implementation strategy, the implementation task team will meet every 3 months to report on progress made on the implementation of the plan within the short term (2008/9).

6.5 Conclusion

An AQMP was developed for the VTAPA during 2007 and 2008. The main objective was to develop a plan that will ensure, once implemented, that air quality in the area will be brought into sustainable compliance with ambient air quality objectives and within agreed timeframes.

The development of the VTAPA AQMP followed a participatory approach through the development of an Air Quality Officers Forum and a Multi Stakeholder Reference Group and identification of interested and affected parties. The Air Quality Officers Forum and a Multi Stakeholder Reference Group met every month during the

development of the plan, and will meet every third month during the implementation of the plan. In addition, two public workshops were held, allowing all stakeholders to partake in the process.

The AQMP is based on scientific data obtained from the baseline characterisation study conducted in 2007. All sources of emissions were identified and quantified with dispersion modelling conducted to determine the current state of air quality within the Vaal Triangle. This was done for the criteria pollutants of PM_{10}, SO_2 and NO_2. The predicted concentrations were verified through available ambient monitoring data. Predicted PM_{10} ground level concentrations exceeded the VTAPA air quality objectives within six areas, called "hotspot zones". Exceedances of acute SO_2 and NO_2 concentrations were predicted in localised areas. The main contributing sources were identified and the percentage reductions required to bring the ambient air quality in line with the air quality objectives were calculated. Based on this, all contributing sources developed emission reduction strategies, which were included into the final intervention strategies. The various spheres of government responsible for the implementation of the plan were assessed in terms of capacity, organisational structures, systems and air quality management tools.

In addition to the impact zones, eleven problem complexes were identified i.e. (i) Biomass Burning, (ii) Domestic Fuel Burning, (iii) Iron and Steel, and Ferroalloys, (iv) Mining, (v) Petrochemical, (vi) Power Generation, (vii) Small Industries, (viii) Transportation (ix) Waste Burning (x) Government Capacity for Air Quality Management, and (xi) Information Management. A problem tree was established for each problem complex and turned into an objectives tree for which strategies and interventions were developed. The emissions reduction strategies were linked to the intervention strategies within the relevant problem complex. The intervention strategies included an implementation timeframe, the parties responsible for the intervention and the current status. A number of interventions within each problem complex were expanded into action plans providing assumptions associated with the intervention strategy, estimated costs, timeframes and indicators.

A manual for the development and implementation of priority areas AQMP was drafted to assist national, provincial and local authorities in developing and implementing AQMPs. The plan will be reviewed within two years, realigning the intervention strategies to ensure continuous improvement in ambient air quality.

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Airshed	Airshed Planning Professionals (Pty) Ltd
AEL	Atmospheric Emissions License
AMSA	ArcelorMittal South Africa
APCD	Air Pollution Control Directorate
APCO	Air Pollution Control Officer
APPA	The Atmospheric Pollution Prevention Act (Act No.45 of 1965)
AQA	National Environmental Management: Air Quality Act (Act No. 39 of 2004)
AQM	Air Quality Management
AQMP	Air Quality Management Plan
AQO	Air Quality Objectives
AQOF	Air Quality Officer's Forum
BACT	Best Available Control Techniques
BAT	Best Available Techniques
BF	Blast Furnace
BID	Background Information Document
BnM	Basa Njengo Magogo
BTEX	Benzene, Toulene, Ethylene and Xylene
BOF	Basic Oxygen Furnace
BUs	Business Units
CAPCO	Chief Air Pollution Control Officer
CAPEX	Capital Expenditure
CBO	Community Based Organisation
CD	Chief Directorate
CE	Control Efficiency
CEF	Central Energy Funds
CFLs	Compact Fluorescent lights
CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COG	Coke Oven Gas
COJ	City of Johannesburg
CV	Calorific Value
MDALA	Mpumalanga Department of Agriculture and Land Administration
Danida	Danish International Development Agency
DEAT	The Department of Environmental Affairs and Tourism
DM	Distrct Minucipality
DME	The Department of Minerals and Energy
DST	Department of Science and Technology
D_oH	Department of Health
D_oT	Department of Transport
DWAF	Department of Water Affairs and Forestry
EAF	Electric Arc Furnace
EC	The European Community
EHPs	Environmental Health Practitioners
EJP	Environmetal Justice Project
EIP	Environmental Implementation Plan
ELM	Emfuleni Local Municipality

EMP	Environmental Management Plan
ESP	Electrostatic Precipitator
ERS	Emission Reduction Strategies
EU	European Union
FGD	Flue Gas Desulphurisation
FQAs	Frequently Asked Quastions
FSP	Free State Province
GES	Gondwana Environmental Solutions (Pty) Ltd
GDACE	Gauteng Department of Agriculture, Conservation and Environment
GHG	Green House Gas
GIS	Geographic Information System
GP	Gauteng Province
GPRS	Meneral Packet Radio Services
HC	Hydrocarbons
HCL	Hydrochloric Acid
HCN	Hydrogen Cyanide
H_2S	Hydrogen Sulphide
KCL	Potassium Chloride
LEZ	Low Emission Zone
LFA	Logical Framework Approach
LMs	Local Municipalities
mg	Milligram
mg/Nm³	Milligrams per normal cubic metres
MSRG	Multi-stakeholder Reference Group
MSVS	Mittal Steel Vanderbijl Station
NACA	National Association for Clean Air
NAQM	National Air Quality Management
NAQMP	National Air Quality Management Plan
NATIS	National Traffic Information System
NEDLAC	National Economic Development and Labout Council
NF	National Framework
NGOs	Non-Governmetal Organisations
NILU	Norwegian Institute for Air Research
NORAD	Norwegian Agency for Development Cooporation
NO_x	Nitrogen Oxides
NO	Nitric Oxide
NO_2	Nitrogen Dioxide
N_2O	Nitrogen Oxide
NH_3	Ammonia
NORAD	Norwegian Agency for Development Cooperation
NMVOC	Non Methane Volatile Organic Compounds
O_3	Ozone
PAH	Poly-Aromatic Hydrocarbon
Pb	Lead
ppb	Parts Per Billion
ppm	Parts Per Million
$PM_{2.5}$	Particulate Matter with an aerodynamic diameter of less than 2.5μm
PM_{10}	Particulate Matter with an aerodynamic diameter of less than 10μm
PCF	Premier's Co-ordinating Forum
PV	Photovoltaic

QA	Quality Assurance
QC	Quality Control
UPS	Uniterupted Power Supply
RCs	Registration Certificates
RODs	Record of Decisions
ROM	Run of Mine
SAAQIS	South African Air Quality Information System
SABS	South African Bureau of Standards
SACWU	South African Chemical Workers Union
SACSO	South African Confederation of Seniors Organisations
SANS	South African National Standards
SAPIA	South African Petroleum Industry Association
SAWS	South African Weather Service
SCI	Sasol Chemical Industries
SDM	Sedibeng District Municipality
SEA	Strategic Environmental Assessment
SOE	State of Environment
SO_2	Sulphur Dioxide
SO_3	Sulphur Trioxide
SO_x	Oxides of Sulphur
SPL	Spent Pot Lining
SRPP	Social Responsibility Policy Projects
STANSA	Standards South Africa
t.p.a	Tones Per Annum
TSP	Total Suspended Particulates
μ	Micron
μg	Microgram
$\mu g/m^3$	Microgram per cubic metres
UNISA	University of South Africa
US-EPA	United States Environmental Protection Agency
VAPS	Vaal Air Pollution Study
VEJA	Vaal Environmental Justice Alliance
VKT	Vehicle Kilometre Travelled
VOC	Volatile Organic Compounds
VTAPA	Vaal Triangle Airshed Priority Area
VUT	Vaal University of Technology
WBG	The World Bank Group
WHO	The World Health Organisation

GLOSSARY

According to the National Environmental Management: Air Quality Act (Act No. 39 of 2004) (AQA), the following definitions apply:

"**air pollution**" means any change in the composition of the air caused by smoke, soot, dust (including fly ash), cinders, solid particles of any kind, gases, fumes, aerosols and odorous substances.

"**ambient air**" is defined as any area not regulated by the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993).

"atmospheric emission" or **"emission"** means any emission or entrainment process emanating from a point, non-point or mobile sources that result in air pollution.

"greenhouse gas" means gaseous constituents of the atmosphere, both natural and anthropogenic, that absorb and re-emit infrared radiation and includes carbon dioxide, methane and nitrous oxide.

"Department" means the Department of Environmental Affairs and Tourism.

"mobile source" means a single identifiable source of atmospheric emission, which does not emanate from a fixed location;

"municipality" means a municipality established in terms of the Local Government: Municipal Structures Act, 1998 (Act No. 117 of 1998);

"national framework" means the framework established in terms of section 7(1);

"non-point source" means a source of atmospheric emissions which cannot be identified as having emanated from a single identifiable source or fixed location, and includes veld, forest and open fires, mining activities, agricultural activities and stockpiles;

"point source" means a single identifiable source and fixed location of atmospheric emission, and includes smoke stacks and residential chimneys;

"pollution" has the meaning assigned to it in section 1 of the National Environmental Management Act;

"priority area" means an area declared as such in terms of section 18;

"priority area air quality management plan" means a plan referred to in section19;

1 INTRODUCTION

The National Environmental Management: Air Quality, 2004 (Act No. 39 of 2004) has made provision for the identification of priority areas where the air quality is regarded as poor and detrimental to human health and the environment. The declaration of the Vaal Triangle Airshed as a priority area was published in the Government Gazette in terms of Section 18(1) of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) under Notice No. 365 of 21 April 2006, as amended by Notice 711 of 17 August 2007.

The Vaal Triangle Airshed Priority Area (VTAPA) is the first priority area in South Africa and was declared such due to the concern of elevated pollutant concentrations within the area, specifically particulates. Two district municipalities and one metropolitan municipality falls within the priority area namely Sedibeng District Municipality (Gauteng Province), Fezile Dabi District Municipality (Free State Province) and the City of Johannesburg Metropolitan Municipality (Gauteng Province). The local municipalities include Emfuleni Local Municipality and Midvaal Local Municipality in Sedibeng, Administrative Regions 6 (Doornkop/Soweto); 10 (Diepkloof/Meadowlands), and 11 (Ennerdale/Orange Farm) within the City of Johannesburg; and the Metsimaholo Local Municipality (Northern Free State) (Figure 1).

The Vaal Triangle is a highly industrialised area housing numerous industries (such as petrochemical, iron and steel, ferro-alloy, etc.), a coal fired power station, and various smaller industrial and commercial activities giving rise to noxious and offensive gasses. In addition, the Vaal Triangle is also home to large informal settlements using coal and wood as fuel source impacting directly on the health of the people in those areas. A few mining operations, mainly collieries and quarries are located within this Airshed. Other sources of concern contributing to the pollution mixture within the area include vehicle tailpipe emissions, biomass burning, water treatment works and landfill areas, agricultural activities and various other fugitive sources.

Air quality management is primarily the minimisation, management and prevention of air pollution, which aims to improve areas with poor air quality and maintain good air quality throughout. The complex nature of air quality issues within the VTAPA required the adoption of a holistic approach to air quality management in the area. This approach was followed during the development of the VTAPA AQMP.

As part of the requirements for priority areas according to the National Environmental Management: Air Quality Act, 2004 (AQA) an AQMP needs to be developed for the area within a giving timeframe. A consulting team comprising of Airshed Planning Professionals, Gondwana Environmental and Zitholele Consulting was appointed by the Department of Environmental Affairs and Tourism (DEAT) to assist in the compilation of an AQMP for the VTAPA. Another objective of the project was to capacitate the local authorities who will be responsible for air quality management under AQA.

> The main objective is the development of an Air Quality Management Plan for the Vaal Triangle Airshed Priority Area in accordance with the provisions of the Air Quality Act of 2004. This Plan will ensure that once implemented, the air quality of the area will effectively and efficiently be brought into sustainable compliance with National Ambient Air Quality Standards within agreed timeframes.

In order to meet these objectives, immediate goals included:

(a) The development of participation forums to ensure inter-governmental communication (Air Quality Officer's Forum) and interaction but also close cooperation with the key stakeholders (Multi-Stakeholder Reference Group) in the Vaal Triangle.
(b) The planning objective, which entails the methodology and scope of developing and implementing a priority area air quality management plan.
(c) Capacity development to ensure that the various spheres of government (viz. National Government, Provincial Government and District and Local Municipalities) are empowered to implement and maintain the Air Quality Management Plan for the priority area.

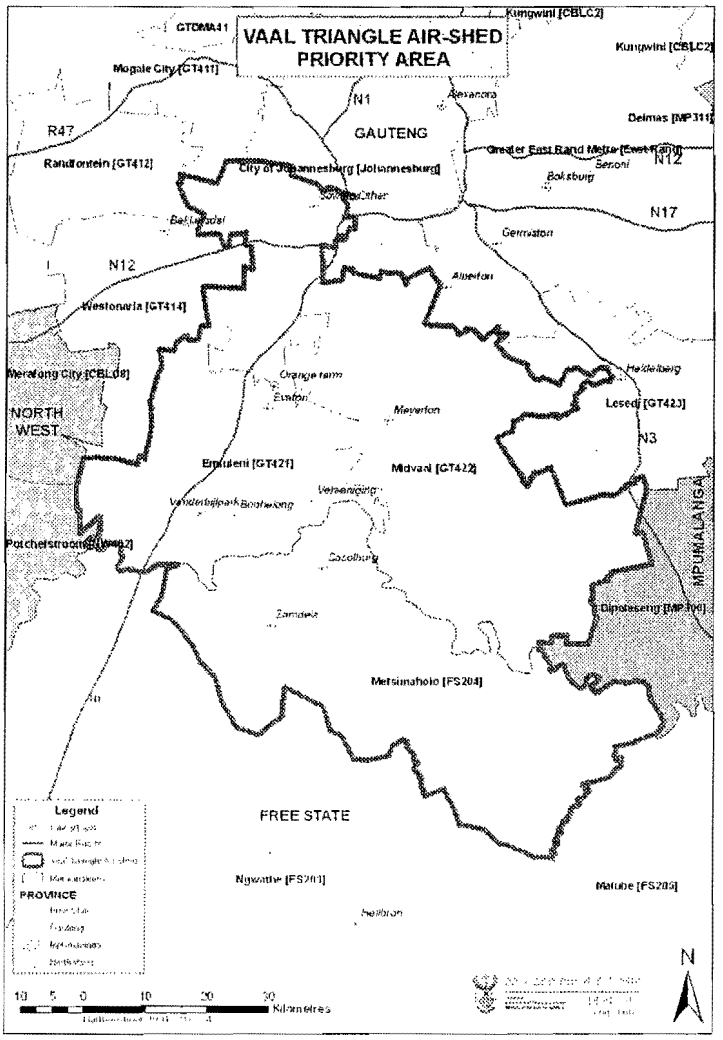

Figure 1: Demarcation of the Vaal Triangle Airshed Priority Area

The immediate project objectives and related outputs are summarised in Table 1.

Reference was made to international and local air quality practices to ensure the plan forms an integral and practical system that will meet the objectives as defined in Table 1. Local municipalities that have developed AQMPs to date include the City of Johannesburg (partly falling within the VTAPA), the City of Tshwane, Ekurhuleni Metropolitan Municipality (bordering the VTAPA), Rustenburg Local Municipality, the City of Cape Town, eThekwini Metropolitan Municipality and Capricorn District Municipality.

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

Immediate Objective	Output	Verifiable Indicator	Means of Verification	Status
A. The Participation Objective	A.1. Efficient and effective intergovernmental coordination and cooperation	Efficient and effective intergovernmental coordination and cooperation.	Meeting Minutes.	Initiated Nov 2006 - completed
	A.2. Efficient and effective public participation	Efficient and effective public participation.	Meeting Minutes and stakeholder feedback.	Initiated Nov 2006 - completed
	A.3. Project website	A project webpage containing current and relevant information relating to the project as available through the department's website.	Stakeholder feedback and webpage hits.	Initiated Nov 2006 - completed
	A.4. Public outreach events and workshops	Well organised public events ensure broad-based public participation.	Event report and feedback.	Initiated Nov 2006 – completed 1st workshop – 13 Feb'07 2nd workshop – 23 Jul'07
B. The Planning Objective	B.1. Process Plan	A clear and unambiguous plan on how Output B is to be generated.	Implementation of the process plan results in the desired outcome.	December 2006
	B.2. Problem Analysis	The causes of current and, potential, future poor air quality in the area are clearly defined and described.	The efficiency of the plan is ensured through interventions that deal with the real causes of poor air quality in the area.	Baseline report – June'07
	B.3. Strategy Analysis	All possible pollution mitigation strategies are described and reviewed.	The plan is directed by practical strategies that ensure a high probability for success.	End July 2007 Outcome of baseline report
	B.4. Intervention Descriptions	Interventions are clearly described that, once implemented, will have a measurable positive impact on ambient air quality in the area.	The plan describes interventions that ensure a high probability for success.	Initiated Aug 2007 Intervention strategies - End June'08 Finalisation – Oct'08
	B.5. Draft Priority Area Air Quality Management Plan	A draft plan based on current, accurate and relevant information, informed by best practice in the field of air quality management and that provides a clear and practical plan to efficiently and effectively bring air quality in the area into sustainable compliance with National Ambient Air Quality Standards within agreed timeframes.	Draft plan published in the *Gazette* for public comment.	November 2007
	B.6. Priority Area Air Quality Management Plan	A plan based on current, accurate and relevant information, informed by best practice in the field of air quality management and that provides a clear and practical plan to efficiently and effectively bring air quality in the area into sustainable compliance with National Ambient Air Quality Standards within agreed timeframes.	Plan published in the *Gazette*.	April 2009

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Immediate Objective	Output	Verifiable Indicator	Means of Verification	Status
C. The Capacity Development Objective	C.1. Implementation Manual	Manual for implemting and developing priority area Air uality anagement plans	Published manual.	April 2009
	C.2. National Priority Area Management Capacity	Active involvement of departmental staff in the implementation of the project.	Staff able to efficiently and effectively manage future priority areas.	Initiated November 2006 – ongoing until 2009 DEAT Workshop - 12 & 13 June'07
	C.3. Implementation Initiated	Assistance provided in the initial plan implementation phase.	Implementation successfully launched.	November 2008

1.1 Methodological Approach for the development of an Air Quality Management Plan for the Vaal Triangle Airshed Priority Area

Objective A – The Preparation Objective

The VTAPA Air Quality Management Plan (AQMP) was developed in accordance with the spirit and letter of the cooperation and participatory government requirements and principles contained in Chapter 3 of the Constitution, the National Environmental Management Act (Act No. 107 of 1989), the Integrated Pollution Prevention and Waste Management Policy (2000) and the Air Quality Act of 2004.

- **Output A.1. Efficient and effective intergovernmental coordination and cooperation**
  Two structures have been established and formed the basis of the participation process namely the Priority Area Air Quality Officer's Forum (AQOF) and the Multi-Stakeholder Reference Group (MSRG). The AQOF acts as the steering committee for the project and comprises of government representatives from all spheres (i.e. National, Provincial and Local). The project team comprised of consultants from Gondwana Environmental Solutions and Airshed Planning Professionals responsible for the technical components of the project and Zitholele Consulting in charge of the public participation process. The project team liaised with the AQOF on a monthly basis.

- **Output A.2. Efficient and effective public participation**
  The MSRG consists of members represented by industry, Non-Governmental Organisations (NGOs) Community Based Organisations (CBO), Labour Organisation, Academia and the public. The main criteria for the MSRG members are those who are familiar with air quality issues, have a scientific background and experience, represent broad organisations and have experience in participating on behalf of their organisations in multi-stakeholder discussions. The MSRG is limited to a number of people and the idea is that the group represent a larger stakeholder group and acts as a sounding board for the project team whilst ensuring the manageability of the group. The project team liaises with the MSRG on a monthly basis.

- **Output A.3. Project website**
  A website for the VTAPA AQMP project was developed and is updated on a regular basis (www.environment.gov.za/vaal). The purpose of the webpage is to provide current and relevant information to keep all stakeholders abreast of progress being made on the project and also to provide them with opportunities to access any reports or other outputs.

- **Output A.4. Public outreach events and workshops**
  The importance of public involvement throughout this project was acknowledged and a database of all interested and affected parties (I&APs) was established at the start of this project. A Background Information Document (BID) was drawn up and sent out to all I&APs and advertisements were placed n various newspapers announcing the workshop that was held on the 13th of February 2007 at Stonehaven on the Vaal in Vanderbijlpark. The workshop served to provide information on the project scope, methodology and final deliverables. The members of the AQOF and the MSRG were introduced during this workshop and communication channels established for the public to be involved.

  The second workshop was held on the 23rd of July 2007 at Stonehaven on the Vaal in Vanderbijlpark. The problem tree and strategy analysis together with the proposed intervention descriptions were presented. This provided the public with the opportunity to give input before the development of the Draft Air Quality Management Plan.

Objective B – The Planning Objective

Objective B comprised the development of an AQMP for the VTAPA based on current, accurate and relevant information. The development of such a plan required various processes, which are described below.

- ***Output B1: Process Plan***
  A Process Plan was developed at the initiation of the project and presented to DEAT for approval. An extension of the project duration (to end September 2007) was motivated due to the importance and complexity of the project. The extension was regarded vital to ensure that sufficient time was allowed for information gathering and public consultation. This was further extended to September 2008 in order to allow all main sources government to develop emission reduction strategies.

- ***Output B2: Problem Analysis***
  The Problem Analysis was entirely based on the outcome of the Baseline Assessment, which was addressed in the VTAPA Baseline Assessment report. Given that the strategy for the Air Quality Management Plan is founded on the Problem Analysis, the importance of a comprehensive, accurate and current baseline assessment was acknowledged.

  The Problem Analysis comprised primarily of two components, namely:
  - Status quo of ambient air quality within the VTAPA; and,
  - Capacity assessment within the various spheres of government.

  The effective characterisation of existing air quality represents the cornerstone of air quality management planning since it facilitates the identification of sources, pollutants and locations of concern. Effective baseline characterisation necessitates an understanding of spatial and temporal variations in pollutant concentrations. This is most effectively achieved through the application of a combination of tools, most notably: emissions inventories, atmospheric dispersion modelling and ambient air quality monitoring. In addition, reference was made to previous studies conducted nationally or within the priority area.

  The status quo of ambient air quality within the VTAPA was structured to identify:
  - key sources of emission;
  - critical pollutants associated with specific sources;
  - spatial variations in emissions; and,
  - possible air pollution 'hot spots' given human health and environment risk potentials.

  All ambient meteorological and air quality monitoring stations within the VTAPA have been identified and data from these stations obtained. This included meteorological stations operated by the South African Weather Services, National Government (DEAT), District Municipalities and industries within the priority area. Ambient air quality monitoring data has also been obtained from various stations within the area and is mainly operated by industry but also by the City of Johannesburg, Sedibeng District Municipality and DEAT. The DEAT stations have only recently been implemented (beginning 2007) with limited data available at the time of the baseline assessment. Most of the operational ambient monitoring stations measure PM_{10} (inhalable particulates) and sulphur dioxide (SO_2), with the addition of oxides of nitrogen (NO_x), nitric oxide (NO), nitrogen dioxide (NO_2), ozone (O_3), carbon monoxide (CO) and hydrocarbons (benzene, toluene and xylene), and even $PM_{2.5}$ (respirable particulates) at some of the stations. All available data were obtained and included to inform the baseline assessment.

  The development of an emissions inventory for the VTAPA was based on the study conducted by Scorgie in 2004 (Air Quality Situation Assessment for the Vaal Triangle Region) and the information used to inform the NEDLAC "Dirty Fuels" Project (Scorgie *et al.*, 2004). Pollutants of concern were identified based on the available emissions data and on information in the literature with regard to the nature of pollutants

associated with specific source types. In an attempt to update the emissions inventory for the area, questionnaires were sent out to all identified industries. A two-month period was allowed for the completion and return of the questionnaire but unfortunately, a very poor response was received. Where data could not be collected through questionnaires (i.e. informal settlements and traffic) use was made of emissions quantification by means of emission factors and international accepted methodologies. Information on vehicle activity in the area was obtained from National Traffic Information System (NATIS) and the South African Petroleum Industry Association (SAPIA). For domestic fuel burning, use was made of the 2001 Census database with additional surveyed information for Zamdela supplied by the NOVA Institute. The aim was to develop a current, accurate and representative emissions inventory for the VTAPA for future use as part of the Air Quality Management Plan implementation

A regional dispersion model was used namely the United States Environmental Protection Agency (US-EPA) CALMET/CALPUFF suite of models. CALPUFF is a regional Lagrangian Puff model suitable for application in modelling domains of 50 km to 200 km. Due to its puff-based formulation the CALPUFF model is able to account for various effects, including spatial variability of meteorological conditions, dry deposition and dispersion over a variety of spatially varying land surfaces. The simulation of plume fumigation and low wind speed dispersion are also facilitated. The CALMET model was used to generate a three-dimensional wind field for input to the CALPUFF model based on input from multiple surface and upper air meteorological stations. The CALMET meteorological model contains a diagnostic wind field module that includes parameterized treatments of terrain effects, including slope flows, terrain channelling and kinematic effects, which are responsible for highly variable wind patterns. The updated emissions inventory was used as input into the regional air dispersion model together with meteorological data obtained for the area.

The results from the dispersion model together with ambient monitored data were used to determine compliance of the ambient air quality with National standards and the potential impacts on human health and the environment. The Ambient Air Quality Standards for Common Pollutants (as was published on the 9th of June 2006 as proposed National standards) were used as ambient air quality targets for all air quality interventions in the VTAPA. Based on the main findings of the baseline assessment, areas of concern were identified and pollutants and sources were ranked based on contribution to the ambient air quality. This information will be used to inform the problem tree and strategy analysis.

The capacity assessment of all government spheres involved in the implementation of the AQMP for the VTAPA was identified. Questionnaires were drawn up and send out to National, Provincial and Local Government to obtain relevant information on the current management procedures and operational structures pertaining to air pollution management within each government sphere. This was used to determine the nature and status (in terms of degree of completion) of AQM Strategies and AQM Systems developed by metropolitan areas within the study area (i.e. City of Johannesburg). The information was also used to determine the current capacity within each government sphere in both human resources but also financial resources and hardware and software (i.e. dispersion models, emissions database, vehicle models etc.). Additional information such as complaints registers were also inventoried as part of the problem analysis.

- ***Output B3: Strategy Analysis***

  The Strategy Analysis was completely based on the outcome of the Baseline Assessment highlighting all current and probable problems pertaining to air quality management in the Vaal Triangle. A problem tree was developed with a parallel objectives tree. A workshop with all MSRG and AQOF members were conducted on the 12th and 13th of July 2007 in the Vaal Triangle. The methodology followed the outline of the Logical Framework Approach (LFA) and determined strategies and interventions based on identified problems through brain storming sessions. A Strategy Analysis is a systematic way of searching for and deciding on problem solutions. It follows the Problem and Objectives analysis and is a prerequisite to designing action strategies. This involves the selection of a strategy to achieve the desired results and

comprises the clusters of objectives to be included in the project. Strategy Analysis also looks at the feasibility of different interventions.

- ***Output B4: Intervention Descriptions***
  The interventions are actual procedures to be followed with specific timeframes attached to it. These interventions apply to industry, government and to a lesser extend the public. Feasible and manageable interventions were determined over the short- and medium term with specific actions linked to each and the responsible persons or divisions or industries identified. Each of these sectors was consulted in the drafting of such interventions.

- ***Output B5: Draft Priority Area Air Quality Management Plan***
  The main objective of the AQMP developed for the VTAPA is to ensure a holistic air quality management approach. All the immediate objectives were incorporated as chapters into the Plan. This provides for a logical setup of the Plan and assist in the implementation of it.

- ***Output B6: Priority Area Air Quality Management Plan***
  The comments from the public and all stakeholders will be incorporated into the Air Quality Management Plan (AQMP). Where information became available during the period leading up to the finalisation of the AQMP, this will be included and the plan updated accordingly. The final report will be submitted to DEAT for implementation.

Objective C – The Capacity Development Objective

Affected government departments are provided with initial assistance in the implementation of the Vaal Triangle Airshed Air Quality Management Plan and the department is able to efficiently and effectively manage all future priority areas.

- ***Output C1: Implementation Manual***
  The requirement for an implementation manual is mainly to capture the methodology and strategies adopted during the development of the AQMP for the VTAPA. Reference will be made to the draft Implementation Manual for Air Quality Management in Priority Areas. The manual will capture detailed steps taken throughout the development and implementation of the plan.

- ***Output C2: National Priority Area Management Capacity***
  The project team will transfer skills and built capacity throughout the duration of the project through involving government officials in the process and through specific workshops. The workshops will specifically focus on the technical side of the AQMP development process such as the development of emissions inventories, dispersion modelling, and data capture and analysis of data.

- ***Output C3: Implementation Initiated***
  Similar to the capacity building support to be provided, this will basically be a continuation for supplying support and assisting government with the implementation of the air quality management plan.

1.2 Best Practice in Air Quality Management

Air quality management is primarily the minimisation, management and prevention of air pollution, which aims to improve areas with poor air quality and maintain good air quality throughout. Invaluable lessons can be learnt from the experience obtained through Air Quality Management practices internationally and locally.

Criteria that will influence the VTAPA AQM Plan development include:

- National and Provincial requirements,
- AQM Plan development by other metropolitan Municipality within South Africa and international best practice pertaining to AQM Plan development and implementation.

In order to pre-empt such influences the project team liaised closely with national and provincial departments on developments with regard to guidelines for local AQM Plan development, and other metros (viz. City of Johannesburg) regarding their AQM development processes. This was done through the AQOF. Criteria defining international best practice with regard to AQM Plan development and implementation was collated as part of a situation assessment study conducted for the City of Cape Town (Scorgie *et al.*, 2002).

1.2.1 Local Experience

According to the Constitution, municipalities have the executive authority in respect of air pollution control. The new National Environmental Management: Air Quality Act of 2004[1] has shifted the focus away from centralised air pollution governance to the decentralisation of power, placing the responsibility of air quality management on the shoulders of local authorities. These responsibilities include the characterisation of baseline air quality, the management and operation of ambient monitoring networks, the licensing of listed activities, and the development of emissions reduction strategies. In order to fulfil these responsibilities local authorities will be required to develop AQMPs as part of their Integrated Development Plans (IDPs). In the case of the VTAPA, the development of an AQMP involves various spheres of government (Local, Provincial and National) with more than one local and provincial authority involved. The main aim of an AQMP is however to achieve the objective of the Act which is to ensure the protection of the environment and human health through reasonable measures of air pollution control within the sustainable (economic, social and ecological) development framework.

In South Africa various Metropolitan Municipalities have stepped up to the responsibility as stipulated in the Act and have developed AQMPs. These are stipulated in Table 2. A brief description of the Air Quality Management Plans and current status are provided for the City of Johannesburg, the City of Cape Town and the eThekwini Metropolitan Municipality.

Table 2: Air Quality Management Plans for Municipalities in South Africa.

Municipality	Province	AQMP Approved by Council	AQMP Launched
City of Johannesburg Metropolitan Municipality	Gauteng	April 2003	April 2003
Ekurhuleni Metropolitan Municipality	Gauteng	May 2004	September 2004
City of Cape Town Metropolitan Municipality	Western Cape	April 2006	April 2006
Rustenburg Local Municipality	North West	October 2006	October 2006
Capricorn District Municipality	Limpopo	July 2006	2007
City of Tshwane Metropolitan Municipality	Gauteng	September 2006	September 2006
eThekwini Metropolitan Municipality	KwaZulu Natal	April 2007	April 2007

[1] The National Environmental Management: Air Quality Act (Act no.39 of 2004) commenced with on the 11th of September 2005 as published in the Government Gazette on the 9th of September 2005. Sections omitted from the implementation are Sections 21, 22, 36 to 49, 51(1)(e),51(1)(f), 51(3),60 and 61 Sections 21, 22, 36 to 49, 51(1)(e),51(1)(f), 51(3),60 and 61.

1.2.1.1 City of Johannesburg Air Quality Management Plan

The *City of Johannesburg* was the first Metropolitan Municipality to develop an Air Quality Management Plan in 2003. The main objectives identified for the City of Johannesburg together with the emission reduction measures stipulated are provided in Table 3 (Scorgie *et.al.*) The City if Johannesburg is currently reviewing the Air Quality Management Plan through a Multi Stakeholder Reference group.

1.2.1.2 City of Cape Town Air Quality Management Plan

The *City of Cape Town* launched its Air Quality Management Plan in April 2006. The main purpose of the plan is to ensure that clean air is achieved and maintained in the City over the next 10 to 20 years. The plan contains the vision, mission, objectives, strategies and actions needed to achieve this. The Air Quality Management Plan for the City of Cape Town contains 11 main objectives in order to meet its commitment 'To be the City with the cleanest air in Africa'. These objectives together with the relevant strategies and actions are provided in Table 4 (http://www.capetown.gov.za/clusters/health.asp).

1.2.1.3 eThekwini Metropolitan Municipality Air Quality Management Plan

eThekwini Metropolitan Municipality developed an Air Quality Management Plan based on the Durban South Multi-point Plan. The eThekwini Municipality had the advantage of having successfully implemented the Multi-point Plan since it received Cabinet endorsement in October 2000. Despite the noticeable reductions in sulphur dioxide emissions and the improvements in air quality management, it was still necessary to develop an AQMP for the metropolitan.

Stakeholders were involved from the initiation of the AQMP development process in November 2005. Thematic topics selected for incorporation into an AQMP were sulphur dioxide, particulate matter, benzene, odours, Jacobs industrial complex, flaring and indoor air quality in informal settlements. The prioritisation was based on data from air quality monitoring network, health studies undertaken and record of public complaints (NILU, 2007). The methodology included a description on of each of the thematic areas on the nature of the issue, its compliance status, possible causative factors and gap analysis.

The AQMP was developed as a guiding document providing a number of possibilities for abatement for each air quality issue identified and prioritised. The synthesis of these strategies into actions with both political and management support will be incorporated into an air quality master plan. The process is subject to monitoring and reviews every 5 years and the air quality monitoring network, stakeholder feedback and complaint statistics will be used in the evaluation process. The performance of the AQMS and further set of actions (master plan) will be reported annually in the annual reporting process (NILU, 2007).

1.2.2 International Best Practice

The scope and content of AQMPs developed by cities and regions within various countries were reviewed to inform the development of local Air Quality Management Plans, including Australia (Perth), United Kingdom (London), USA (Los Angeles, San Francisco, State of Massachusetts, Boston), Canada (Fraser Valley Regional District), Mexico (Mexico City) and China. Critical success factors for an AQMP were identified based on international experience. Such factors were used as the basis for the development of an AQMP Development Framework and for drafting of a comprehensive list of contents for consideration in terms of the structuring the

AQMP. A summary of the air quality management strategies in various cities across the globe are provided in Table 5.

Table 3: Synopsis of emission quantification and emission reduction measures for the City of Johannesburg (Jun 2003 to June 2008) taken from the Air Quality Management Plan implemented in 2004 (Scorgie *et.al.* 2003).

Sector:	Action	Responsibility:	Recommended Timeframe:
Domestic Fuel Burning	Establishment of a Working Group on Domestic Fuel Burning	JHB AQM Function	Sept 2003
	Drafting of a coherent Strategy, Implementation Programme and Budget for domestic fuel burning mitigation in the short- to medium-term	Working Group on Domestic Fuel Burning	Dec 2003
	Implementation of *short-term* domestic fuel burning mitigation measures included in the Strategy and Implementation Programme developed by the Working Group on Domestic Fuel Burning	Implementation by JHB AQM Function, coordination by Working Group on Domestic Fuel Burning	Jan 2004 ongoing
	Assess, at 3-monthly intervals of progress made in programme implementation based on the review of air quality improvements realised in areas where domestic fuel burning mitigative measures have been introduced	Implementation by JHB AQM Function, coordination by Working Group on Domestic Fuel Burning	On-going following Domestic Fuel Burning Mitigation Implementation Programme adoption (Jan 2004)
	Investigation of the cost-effectiveness of expanding the natural gas reticulation network to the domestic sector.	JHB AQM Function	August 2003 ongoing
	Coordinate the City's revise local building codes and housing policy to ensure that all new housing developments are energy efficient.	JHB AQM Function	August 2003 ongoing
	Investigation and identification of suitable opportunities for the introduction of feasible renewable energy alternatives.	JHB AQM Function	August 2003 ongoing
	Implementation of *medium-term* domestic fuel burning mitigation measures included in the Strategy and Implementation Programme developed by the Working Group on Domestic Fuel Burning	Implementation by JHB AQM Function, coordination by Working Group on Domestic Fuel Burning	July 2005 ongoing
	The AQM function will facilitate the investigation and identification of suitable opportunities and mechanisms for the introduction of feasible renewable energy alternatives, increased energy-efficiency through retrofitting of public and corporate buildings within the City, cleaner technology and other emission reduction programmes, and improved access of poorer households to clean energy, giving consideration to potential resourcing opportunities such as the Cleaner Development Mechanism, carbon credit trading systems and long term business efficiencies and cost savings.	JHB AQM Function	August 2003 ongoing

Sector:	Action	Responsibility:	Recommended Timeframe:
Mine Tailings	City of Johannesburg will be represented on the inter-departmental committee tasked with the regulation of mining operations and tailings impoundments (DWAF, DME and GDACE are currently represented on the committee).	JHB AQM Function	August 2003 ongoing
	The recommended dust management planning approach and results from literature review on dust control measures will be communicated to the Mine Pollution Forum for consideration by the technological sub-committee tasked with control measure review.	JHB AQM Function	August 2003 ongoing
	The inter-departmental committee on mine tailings and the Mine Pollution Forum will be encouraged to require the adoption of a comprehensive dust management planning approach and the implementation of effective dust controls by local mines.	JHB AQM Function	August 2003 ongoing
	An awareness raising and information dissemination programme on dust impacts and mitigation related to mine tailings, specifically aimed at impacted communities, will be established.	JHB AQM Function	August 2003 ongoing
	The local dust deposition guidelines will be implemented, and it will be ensured that mitigative action is undertaken when the alarm threshold is exceeded.	JHB AQM Function	August 2003 ongoing
Transportation and Traffic	Establishment of an *Inter-departmental Transport Liaison Group* comprising members of the Johannesburg Air Quality Management function and personnel from the Johannesburg Transportation Planning department	JHB AQM Function	Jun - Jul 2003
	Methods used by each Region in their testing of diesel vehicle emissions will be standardised and a target number of vehicles to be tested each month within each Region established	JHB AQM Function	July - Dec 2003
	Mechanisms will be established for gaining cooperation of metro police for the purpose of supporting the diesel vehicle emissions programme in Regions where such mechanisms are lacking	JHB AQM Function to coordinate	July - Dec 2003
	Coordination of regular emission testing of metro buses at the municipal testing station when such vehicles undergo their regular Certificate of Fitness examinations	JHB AQM Function to coordinate	
	Design a comprehensive and effective vehicle emission testing programme for implementation in the medium-term	JHB AQM Function	July 2003 - Dec 2004
	Obtain information required for the quantification of vehicle emissions from Transportation Planning	JHB AQM Function	Sep 2003 - Mar 2004
	Provision of the information required by Transportation Planning (viz. annual literature surveys of transport-related emissions and air quality impacts)	JHB AQM Function	July 2003 – Jun 2005
	Integration of transport-related monitoring requirements into the JHB City ambient air quality monitoring activities	JHB AQM Function	July - Dec 2003
	Provision of a checklist of emission reduction measures for consideration by Transportation Planning in their planning and decision making processes	JHB AQM Function	July 2003 - Jun 2005
	Encourage research into cleaner transportation technologies through liaising with the Transportation Planning project manager on the Clean Transport Technology Project via the *Inter-departmental Transport Liaison Group* and liaison with GDACE to integrate findings from their cleaner technologies initiative and to avoid duplication	JHB AQM Function	July 2003 - Jun 2005
	Assist Transportation Planning in the development of an emission calculation and air quality impact assessment sub-module for inclusion in the Transport Decision Making Model.	JHB AQM Function	Dec 2003 ongoing
	Use of results from Transportation Planning and GDACE cleaner transportation technology research initiatives in informing public and government related transport decisions.	JHB AQM Function	July 2005 - Jun 2008
	Formation of a *Transportation and Land-use Planning Liaison Group* comprising members from the AQM function, Transportation Planning, Spatial Planning and Housing	JHB AQM Function to coordinate	July 2005 - Jun 2008

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Sector:	Action:	Responsibility:	Recommended Timeframe:
Waste - Landfills	Consultation with the CMU with the purpose of: (i) drawing up strict performance indicators for inclusion in the contract with the waste disposal company contracted to provide waste removal services in areas where informal waste burning is an issue; (ii) compiling a checklist of landfill site evaluation criteria for the purpose of CMU evaluations and contract negotiations; (iii) implementing stipulations for garden refuse sites and transfer stations with regard to avoiding waste burning	JHB AQM Function	July 2003 - Jun 2005
	The City of Johannesburg will request to be represented at DWAF meetings held to discuss local landfill sites. (DWAF national and regional departments and landfill operators attend such meetings).	JHB AQM Function to coordinate	July 2003 - Jun 2005
	Request feedback from GDACE, DWAF and CMU site inspections of landfill operations.	JHB AQM Function	July 2003 - Jun 2005
	Require landfill operations within the City to undertake the following: (i) compile a speciated substance emissions inventory (to be updated annually) based on subsurface gas network sampling; (ii) ambient air quality monitoring of select toxic and odoriferous substances - with substances selected on the basis of the site-specific emissions inventory; (iii) flag air pollutant concentrations resulting in unacceptable health risks; (iv) commission a quantitative air quality impact assessment should health risks be flagged	JHB AQM Function to coordinate	July 2003 - Jun 2005
	Investigation of short-term methods of waste recycling, e.g. through the support of local buy-back centres.	JHB AQM Function	July 2003 - Jun 2005
Waste - Incineration	Initiate an investigation into the legal status of medical waste incinerators operating within the City of Johannesburg.	JHB AQM Function	July 2003 - Jun 2005
	Consult with DEAT and GDACE to ensure that all incinerators are permitted and are operating according to permit requirements	JHB AQM Function	July 2003 - Jun 2005
	Collate source and emissions data for incinerator operations and undertake an air quality impact assessment, including a health risk screening study, to determine the acceptability incinerators for the purpose of informing the permit revision process	JHB AQM Function	July 2005 - Jun 2008
Waste - Sewage and Waste Water Treatment Works	Require that sewage and waste water treatment works operating within the City undertake the following: - compile a speciated substance emissions inventory (to be updated annually) based on site-specific samples - ambient air quality monitoring of select toxic and oderiferous substances - with substances selected on the basis of the site-specific emissions inventory - flag air pollutant concentrations resulting in unacceptable health risks - commission a quantitative air quality impact assessment should health risks be flagged	JHB AQM Function to coordinate	July 2003 - Jun 2005
	Design and initiate an education and awareness campaign on waste segregation	JHB AQM Function	July 2005 - Jun 2008
	Commission a cost-benefit study on waste segregation and recycling strategies applicable for implementation within Johannesburg	JHB AQM Function	July 2005 - Jun 2008
	Consolidate findings of investigations into alternative treatment and disposal options and support additional investigations where required. Integrate findings on alternatives in EIA reviews and local waste management policies	JHB AQM Function	July 2005 - Jun 2008
Industry	Establishment of on-going communication with the Air Pollution Control Officer responsible for the Schedule Processes within the City to enable source and emissions data on 'Scheduled Processes' contained within the emissions inventory to be updated	JHB AQM Function	July 2003 - Jun 2005
	Collation of all information related to non-domestic fuel burning appliances required for the estimation of emissions and the modelling of air quality impacts	JHB AQM Function	July 2003 - Jun 2005

	Estimate emissions and predict air quality impacts associated with non-domestic fuel burning appliances	JHB AQM Function	July 2003 - Jun 2005
Sector:	**Action**	**Responsibility:**	**Recommended Timeframe:**
Industry	Reinforcement of the rule that the installation of all new non-domestic fuel burning appliances and any major appliance renovation or alteration project will require the notification of the City.	JHB AQM Function to coordinate	July 2003 - Jun 2005
	Set specifications on combustion efficiency applicable to all new combustion devices	JHB AQM Function to coordinate	July 2005 - Jun 2008
	Liaise with Eskom on demand side management measures applicable to the commercial and industrial sectors	JHB AQM Function to coordinate	July 2005 - Jun 2008
	Investigate the potential for introducing alternative tariff structures for the purpose of encouraging on-site co-generation and the introduction of renewables	JHB AQM Function to coordinate	July 2005 - Jun 2008
Other Sources	Identify and quantify additional sources of pollution	JHB AQM Function	July 2003 - Jun 2005
	Establish routine data retrieval mechanisms for the purpose of updating the emissions inventory	JHB AQM Function	July 2003 - Jun 2005
	Control the burning of grass by municipal worker's along highways and elsewhere	JHB AQM Function to coordinate	July 2003 - Jun 2005
	Reinforce the need for dust suppression required to be implemented by mines and quarries along unpaved haul and access roads	JHB AQM Function	July 2003 - Jun 2005
	Support national legislation aimed at controlling copper wire burning for the purpose of wire stripping	JHB AQM Function to coordinate	July 2003 - Jun 2005
	Investigate the use of by-law implementation for the purpose of: (i) controlling track out from construction sites, (ii) stipulating the need for dustfall monitoring and reporting of results during large-scale construction and demolition projects.	JHB AQM Function to coordinate	July 2003 - Jun 2005
	Identification of emission reduction measures for other sources predicted on the basis of the quantitative emissions inventory to be significant in terms of health risks or nuisance impacts.	JHB AQM Function	July 2005 - Jun 2008
Education and Awareness Campaigns	Consolidate individual awareness and education initiatives required within a coherent public education and awareness programme	JHB AQM Function	July 2003 - Jun 2005

Table 4: Air Quality Management Plan for the City of Cape Town (report AQM 20050823 -001).

	Objective	Strategy	Time frame (1)	Action
1	To formulate an air quality management system for the City of Cape Town	1.) Develop a Air Quality Management System for the City of Cape Town	medium	The existing Air Quality Management Task Team to investigate and ensure the cross-cutting nature of the system with all the objectives detailed in the AQMP
		2.) Identify the cross-cutting nature of this strategy and all of the other key objectives	short / medium	
2	To specify ambient air quality standards and targets for Cape Town	1.) Implement National Ambient Air Quality Standards once these are available	short / medium	Establish Air Quality Monitoring and Standards Working Group
		2.) Adopt SANS 1929:2004 and SANAS 69:2004 ambient air quality - limits for common pollutants as standards for the City of Cape Town in the absence of national standards	short	Establish the terms of reference to implement the key strategies of this objective
		3.) Identify appropriate short, medium and long-term targets for air quality in Cape Town	short / medium	
3	To monitor priority pollutants which cause brown haze and affect human health	1.) Identify and establish air quality guidelines and measure air pollution against the established guidelines	current	Continue to monitor air quality at the established monitoring sites and evaluate the data against current air quality guidelines as detailed in the State of Environment Report of the City of Cape Town.
		2.) Maintain the existing monitoring network in the City	current	
		3.) Investigate and set up monitoring strategies for the measurement of other pollutants of concern that are not currently monitored (e.g. total Volatile Organic Compounds (VOCs) benzene, $PM_{2.5}$)	medium	
		4.) Evaluate and report daily on air quality, as well as in the annual Statement of Environment report for the City	current	Air Quality Monitoring and Standards Working Group to develop the terms of reference to implement strategies 3 to 6 of this objective
		5.) To accredit the air quality monitoring network accordance in terms of ISO 17025	short / medium	
		6.) Expand the monitoring capabilities across the city	long term	
4	To improve air quality in informal areas to thank all interested and affected parties	1.) Select an area in Khayelitsha as a pilot project for intervention	current	Khayelitsha Air Pollution Strategy (KAPS) Working Group (already established) to implement strategies 1 to 6 above.
		2.) Use community workers to conduct a detailed survey of households, business, transport and other potential sources of air pollution	short	
		3.) Compile a detailed emission inventory for the area	short	
		4.) Workshop sustainable and economical interventions to reduce air pollution with the community	short	The City to roll out similar projects in other informal areas.
		5.) Pilot test interventions and monitor their effectiveness	short / medium	
		6.) Greening (planting of vegetation) to be investigated to reduce air pollution	medium	
5	To enforce current and future legislation for air quality management: AQA	1.) Implement the Act	short /medium	Air Pollution Control Section of the City Health Department initiate actions to implement strategies 1 to 5. In cooperation with all spheres of government, industry and the community.
		2.) Set up processes to introduce licensing fees for listed industries and accrue the fees for the purpose of air quality management	short	
		3.) Review current permits issued in terms of the Atmospheric Pollution Prevention Act	current	

	Objective	Strategy	Time frame (1)	Action
		4.) Capacity-building	current	
		5.) Communication with industries and communities	current	
5	To enforce current and future legislation for air quality management: Air Pollution Control By-laws	1.) Continue with the effective implementation of the by-law	current	Air Pollution Control By-law of the City of Cape Town
		2.) Effectively deal with complaints	current medium	
		3.) Review by-law		
		4.) Support Government initiatives and legislative approaches to institute a cradle-to-grave concept for the disposal of tyres in South Africa	short term	
		5.) Investigate the revision of the by-law to address the control and regulation on the disposal of tyres in the City - in the absence of national legislation.	medium	Air Pollution Control Section to continue with the implementation of the by-law and implement actions for strategies 1 to 6
		6.) Investigate the revision of the by-law to enforce air quality standards adopted in the City	medium	
6	To compile a comprehensive emissions inventory database for the City of Cape Town	1.) Develop a comprehensive and effective emission inventory	short / medium	The Air Quality Standards and Working Group to investigate and source a suitable emissions inventory database with associated software, training and modelling capabilities.
		2.) Make the inventory accessible to the public	medium / long	
		3.) Regularly update the inventory	short	
		4.) Link inventory to other data sources within and outside the Council	long	
		5.) Validate inventory with monitoring data	short	
		6.) Link emission inventory to suitable Airshed modelling programme for health risk assessments	medium / long	
7	To control vehicle emissions in Cape Town	1.) Support national initiatives such as: ▪ fuel reformulation ▪ motor vehicles emission control	current	Establish a Transport, Planning and Vehicle Emission Working Group to implement the strategies under 1 -7
		2.) Support improved public transport system to limit the influx of vehicles into the city as well as the use of private vehicles	short / medium	
		3.) Encourage the use of carpools	short	
		4.) Continue diesel vehicle testing and enforcement of emission requirements	current	
		5.) Encourage the use of vehicles fitted with emission control equipment	medium	
		6.) Introduce vehicle emission testing with regular road worthy testing	medium / long	
		7.) Support introduction of the clean-burn technology	current / ongoing	
8	To consider air quality in land use and transport planning	1.) Develop guidelines for the modelling and prediction of air quality impacts, for use in transport and land use planning	long	Transport, Planning and Vehicle Emissions Working Group to develop terms of reference that will support and ensure the implementation of the above-mentioned strategies.
		2.) Reduce the number of vehicle trips within the City of Cape Town	long	
		3.) Support and encourage a safe and more reliable public transport system	long	
		4.) Support cleaner fuel and renewable energy sources for domestic, transport and industrial use	current / ongoing	

	Objective	Strategy	Time frame (1)	Action
9	To determine the detrimental health effects of poor air quality on the population of the City of Cape Town	1.) To determine the relationship between the City of Cape Town's air quality and adverse health effects	medium	Establish a Health Working Group of specialists on health effects and air quality and identify key role players to serve on it
		2.) Identify and support research priorities with respect to these adverse health effects	medium	Establish terms of reference, funding sources and research opportunities to implement above strategies.
		3.) Identify funding sources for these health priorities	short	Investigate the association between mortality, morbidity, air quality and hospitalisation as well as the relationship between these and priority pollutants
10	To establish a comprehensive education and communication strategy for air quality management	1.) Develop the appropriate resources and tools for community awareness and education	short / medium	Establish a Public Awareness and Education Working Group to formulate terms of reference for the above strategies.
		2.) Establish links with polluting industries and businesses in order to encourage best practice and reduction at source strategies	short / medium	
		3.) Publish an annual update of resources, tools and approaches to air quality management, linked to the annual State of the Environment Report	medium	
11	To periodically review the air pollution situation, report on progress and adjust and update strategies and objectives where needed	1.) To report annually on trends of air pollution	current	Compile an annual report on air quality trends, complaints, fuel usage, law enforcement and other indicators that enable the City to assess the state of the air quality environment.
		2.) To regularly revise and update the Situation Assessment and Air Quality Management Plan	medium	Regularly reassess the City's AQMP with regard to legislative requirements

Notes:

(a) Current – current & ongoing
Short-term - less than 1 year
Medium term – 1-5 years
Long term – more than 5 years

Table 5: Air quality management measures and mitigation strategies implemented in various cities across the world.

CITY & COUNTRY	PROBLEM	OBJECTIVE	STRATEGY	PROGRESS
Beijing, China	Excessive pollution levels due to coal burning and vehicle emissions	Reduction in SO_2 emission levels,	- Stricter emission standards, use of low sulphur or low ash coal. - Promoting of subway and light rail transportation, vehicle inspections. Compulsory vacuum valves installation in 80000cars.	62% of 340,000 inspected vehicles passed, built 16 refueling station for natural gas vehicles, 16,000 buses and taxis converted to gasoline/natural gas dual fuel.
Delhi, India	Increase in air pollution as a result of an increase in industrial units, vehicle population, coal-fired stations, generation of 6000Mt fly ash per day by 3 power plants and particulate rise level due to installation of ESP's at thermal power plants	Improve the existing air quality conditions in the city	- Reduction in lead handling units and unleaded petrol. Improvement of diesel fuel with even lower sulphur content. Introduction of pre-mixed fuels (petrol & oil mixture) for use of two stroke vehicles. - Relocating of illegal industries to new Development of industrial zones. Stack monitoring for stack emissions. Stricter emission norms. - Traffic planning and management to relieve congestion on roads.	Reduction in lead emissions since 1969.
Mexico City, Mexico	High levels of air pollution caused by industrial growth, population increase and proliferation of vehicles and wildfires		Introduction of air quality improvement programmes (PIICA &PROAIRE) in the 1990's,	
Amsterdam, Netherlands	Fuel transport emissions	Less and cleaner traffic in the city	Hydrogen-fuelled vehicles that produce zero direct emissions, fitting soot filters to diesel engines	
Athens, Greece	Air pollution from high concentrations of particles and photochemical smog (excess of Primary pollutants, ozone's and secondary pollutants) &results from a series of chemical reactions driven by sunlight. Increase in vehicles commuting around the city, contributed a lot to air pollution. Air pollution may be responsible for premature deaths.	Improve the existing air quality conditions in the city	- Retirement plan for old cars, new cars equipped with catalytic converters, national inspection of all cars, expansion of subway system, full replacement of old buses with new ones equipped with anti-pollution devices. - Content of sulphur in heavy fuels and unleaded gas was reduced, content of benzene in gasoline was reduced and introduction of natural gas. - Changing daily traffic routes.	Level of SO_2, smoke, NO_x and ozone exhibited a gradual decrease in later years.

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CITY & COUNTRY	PROBLEM	OBJECTIVE	STRATEGY	PROGRESS
Cairo, Egypt	Excessive vehicles emissions, industries polluting	Improvement of air quality	- Alleviating vehicles emission by (a) issuance of licenses and its emissions testing, (b) delivering devices for vehicles emission testing in addition to training those designated to the technical inspection of vehicles using diesel and gasoline and (c) establishment of environmental police. - Relocating of heavily polluting activities outside the populated areas. - Combating industrial pollution by funding the Industrial Pollution Abatement Projects. - Environmental Inspection of Establishments. - The Safe use of the treated sewage Water in the irrigation of Forests-Reduction of dust and sand rates	
Moscow, Russia	Air pollution from constant sources such as Heat Power enterprises, Oil Refining, Petroleum Chemical enterprises, Transport (vehicle emissions), an increase in Industrial development, lots of mining activities and centralised and inefficient coal burning utility plants.	Help atmospheric protection by introducing an ecologically optimal structure of industry and development of safe and clean technology in the future.	- Closed down major polluting factories. - Auto emissions testing, fitting vehicles with catalytic converters. - Ended production of Leaded petrol.	Major improvement in manufacturing process, scientists have received a US patent for a cost-saving air pollution control device that uses more than 99% of polluting molecules.
Milan, Italy	Vehicular traffic and emissions from building-heating systems are identified as main sources of air pollutants	Regulation, management and protection of air quality.	Smog check programme of maintenance and inspecting of vehicles.	1.) Weather conditions have been favourable to atmospheric dispersions and led to an improvement typically of winter pollutant air quality during last years of measurements. 2.) An increase in the average Italian vehicular fleet of catalysed vehicles and the blue stamp measure.

CITY & COUNTRY	PROBLEM	OBJECTIVE	STRATEGY	PROGRESS
Singapore, Singapore	Air pollution from these sources-Burning of fossil fuel for heat generation in industries, electricity generation and transportation	Assessing and evaluating the hazard and pollution impact of the proposed industries to ensure they do not pose unmanageable pollution, health and safety hazards. Reducing vehicles that are produce hazardous emissions on the road	Minimising emissions at sources and minimising impact of residual pollution on surrounding development by property sitting of industries. Conducting emission tests to monitor and measure emissions regularly to comply with the standards. Regular inspections of stationery sources to properly maintain and operate pollution control equipment. Carbing of car ownership was done by increasing purchase and ownership costs of motor vehicles through tariffs and improving public transportation.	Extremely successful in reducing traffic congestion in the peak hours.
London, Brittain	Has the most polluted air in Europe due to traffic	A London wide low emission zone (LEZ), establishing a vehicle fleet register (in reducing emissions), promoting a cleaner road vehicles.	- Encouraging London Boroughs to promote and encourage cleaner vehicles at borough Level. - Working with Technology and fuel suppliers and motor manufactures. - Undertaking investigations and trials of new technologies within in functional body fleets. - Extended the use of Water-diesel emulsion across all vehicles and further development by fuel companies. - Developing and implementing traffic management measures to help reduce emissions and energy use and also encourage safe, economical and considerate driving. - Work with stakeholders to minimise air quality impacts at Heathrow Airport. - Inspection of industrial processes and updating and modifying of permits conditions. - Promotion of composting to help reduce the number of bonfires. - Businesses have to improve the indoor air quality of workplace environment. - Conversion of large boilers to lighter fuel oils/gas.	Improved city's air quality while reducing traffic and encouraged purchases of energy efficient automobiles. Traffic reduction and changes in fleet composition have exceeded the expectations.

CITY & COUNTRY	PROBLEM	OBJECTIVE	STRATEGY	PROGRESS
Berlin, Germany	Traffic being the number one environmental problem as well as Air pollution caused by Power Stations industries and domestic fuel.	Safeguard the reduced levels of SO_2, NO_x and ozone already achieved and ensure that levels of all pollutants continually fall below those in EU guidelines.	- Conversion of 642 smaller brown-coal-fired heating plants to more environmentally friendly fuel. - Conversion of heating systems in public places. Modernised power stations and installed oxide removal equipment. - Converted housing units to energy-saving and low-emission systems as part of a modernisation programme. - Fitted Berlin's major pollutant producer; Klingeberg heating and power station, with a fume desulphurisation plant. - All vehicles with gasoline engines were equipped with catalytic converters. Technical improvement to lorries and buses was made by replacing petrol and diesel with less polluting natural gas including the development of a network of filling stations. A rational traffic handling and control system was developed. - Berlin's ozone measurement network was increased to a total of 10 stations. The formation and distribution of ozone was investigated n a joint project with the Federal State of Brandenburg and in collaboration with scientific groups. - The Federal Emission Protection Act was supplemented to create a legal basis for summer smog ordinance which will include restrictions-for cars with no regulated catalytic converters.	No smog warning issued since 1991. Progress in modernising existing houses, 150,000 houses belonging to construction companies have been converted to energy-saving and low-emission systems as part of a heating modernisation programme. Unfortunately no reduction has been made in nitrogen oxides in the last few years, success in reducing emissions by the industry sector has been balanced out by the increasing emissions of motor vehicles, and this has the effect of increasing near ground ozone levels (summer smog).

CITY & COUNTRY	PROBLEM	OBJECTIVE	STRATEGY	PROGRESS
Brussels, Belgium	Air pollution in the region is highly linked to the transport sector, housing energy consumption and the tertiary sector. Transport alone is responsible for 87% of CO emissions, 89% of PAH emissions, 58%of NO_x, 69% of Lead, 48% of NMVOC. Building heating systems are responsible for 71%of CO_2 emissions and 79% SO_2 emissions.	Reduce air pollution in the industrial zones through use of improved technological standards.	The IBGE gives priority to campaigns to raise awareness and provide information as well as take into account the socioeconomic and cultural composition of population, informing the public has been one of the essential parts of the IBGE's work. Awareness campaigns-(a)-Air Transparency-is the information system on the quality of air in Brussels region (b)-the IBGE runs prevention campaigns to raise public awareness of problems linked to atmospheric pollution and change the attitudes of those responsible. (c)The IBGE is legally obliged to provide a State of the Environment every two years. (d) Preserve the environment get your company to work for company employees-a campaign asking company to voluntarily respect an "Eco-Mobility Charter" and implement a company travel plan to organize their employees' urban travel. (e) Drive without polluting- Targeted at Brussels drivers, offers them a free pollution test for their vehicles. These also included car inspections. (f) Pedal instead-populations were encouraged to use bicycles instead of motor vehicles to reduce emissions.	Emissions of pollution by SO_2 and to a lesser extent have been reduced significantly.
Mumbai, Bombay	Very high incidence of chronic respiratory problems arising from extreme air pollution, causes of air pollution are mainly industries, garbage burning and insufficient control over emissions levels from vehicles.	An intervention plan for cities exposed to hazards	The 22 air monitoring stations carry out routine checks on NO_x, SO_2 and TSP but Carbon monoxide levels aren't monitored. Relocating of industries and increased stack heights together with the introduction of natural gas have proved to be partially successful in slowing the decline of air quality has been encouraged greatly. Use of low-sulphur coal, a relatively small motor vehicle population and the scrubbing effect of the monsoons helps reduce the overall ambient concentrations in the city. Most effective method-slowing the rate of urbanisation.	Domestic emissions have remained relatively constant and are forecast to be stable despite the projected population increase. In 1970's SO_2 levels started to decrease.N0x's rate of increase has slowed in the 1980's.

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1.3 Legislative and Regulatory Framework for Air Quality Management and Planning

The AQA makes provision for the setting of ambient air quality standards and emission limits on National level, which provides the objective for air quality management. In addition, the AQA requires the development of a National Framework (published under Notice No. 30284 of 11 September 2007) which provides national norms and standards for various air quality management components to ensure compliance be achieved with ambient air quality standards and emissions limits.

National, Provincial and Local authorities (District and Metropolitan Municipalities) will be responsible to manage air quality under the National Environmental Management: Air Quality Act, 2004

Section 15 of the Act requires that each national department or province responsible for preparing an environmental implementation plan or environmental management plan in terms of Chapter 3 of the National Environmental Management Act, 1998 (Act No. 107 of 1998) must include in that plan an air quality management plan. Each municipality must include in its integrated development plan contemplated in Chapter 5 of the municipal Systems Act, an air quality management plan. An air quality management plan must achieve the following: (i) improve air quality; (ii) reduce negative impacts on human health and the environment; (iii) address the effects of fossil fuels in residential applications; (iv) address the effects of emissions from industrial sources; (v) address effects from emissions from any point or non-point sources of air pollution; (vi) implement the republic's obligations in respect of international agreements; and, (vii) give effect to best practice in air quality management. The Act also provides for regulations to be made for implementing and enforcing approved priority area AQMPs, which may include, amongst others: (i) funding arrangements; (ii) measures to facilitate compliance with such plans; (iii) penalties for any contravention of any failure to comply with such plans; and (iv) regular review of such plans. The approved Air Quality Management Plan (AQMP) for a priority area must be published in the Gazette within 90 days of approval.

AQA has delineated the responsibility of air quality management between the various spheres of government (i.e. National, Provincial and Local Authorities). This includes responsibilities such as air quality monitoring, emissions monitoring, development of AQMPs, collaboration with national and provincial government and issuing atmospheric emissions licenses for all listed activities. In order to fulfil these functions local authorities will have to appoint a dedicated Air Quality Officer. Provincial authorities will be responsible for similar functions, as would national government. On national level, however the focus is more on policy making and regulations. These roles and responsibilities are summarised in Table 6.

DEAT has embarked on various projects to roll out the AQA. These projects include amongst others the Durban South Multipoint Plan, NEDLAC Dirty Fuel Air Quality Study, SO_2 ambient standard setting initiative, the SABS standard setting approach, the Danida support NAQMP Phase II and IIB Projects, the APPA Permit Review Project, National Framework for Air Quality Management, Listed Activities and Minimum Emissions Standard Setting Project, DEAT Ambient Air Quality Monitoring Project, etc.

Table 6: National, provincial and local government functions as informed by the Air Quality Act

NATIONAL Government Functions and Responsibilities	PROVINCIAL Government Functions and Responsibilities	LOCAL Government Functions and Responsibilities
Establish & review national framework	Air quality monitoring	Air quality monitoring
Identify priority pollutants	Monitor municipality performance	Emission monitoring
Establish national air quality standards	Identify priority pollutants	Identify priority pollutants
Establish national emission standards	Establish provincial air quality standards	Establish local emission standards
Appoint national AQ officer	Establish provincial emission standards	Appoint AQ officer
Integrate AQMPs into their Environmental Management Plans	Appoint provincial AQ officer	Develop and implement AQMP as part of their Integrated Development Plans (IDP)
Declare priority areas	Integrate AQMPs into their Environmental Management Plans	Collaborate with national and provincial government (within priority areas)
Prepare priority areas AQMP	Declare priority areas	Perform emission licensing authority functions (metros and district municipalities)
List activities	Prepare priority areas AQMP	
Declare controlled emitters	List activities	
Set requirements for pollution prevention plans	Declare controlled emitters	
Set regulations for dust, odour, noise	(Perform emission licensing authority functions if no capacity by local authorities)	
Declare and set requirements for controlled fuels	Declare and set requirements for controlled fuels	
Investigate and regulate transboundary pollution		
Investigate potential international agreement contraventions		

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1.3.1 Implementation of the Air Quality Act of 2004

DEAT has embarked on various projects to roll out the AQA implementation. These projects include amongst others the Durban South Multipoint Plan, NEDLAC Air Quality Study, SO_2 ambient standard setting initiative, the SABS standard setting approach, the Danida support NAQMP Phase II and IIB Projects, the APPA Permit Review Project, National Framework for Air Quality Management, Listed Activities and Minimum Emissions Standard Setting Project, DEAT Ambient Air Quality Monitoring Project, etc.

The main projects directly affecting the development of the VTAPA Air Quality Management Plan includes:

- *The Durban South Multipoint Plan* – The pilot project was to be used to test and inform strategies for dealing with air pollution 'hot spots' and local government roles and responsibilities. Key project areas of the Multipoint Plan included, the establishment of a modern air quality management system, undertaking a health study to characterise exposure levels, setting air pollution standards, phasing out dirty fuels in an attempt to reduce sulphur dioxide pollution and managing fugitive emissions. This was used to inform the Air Quality Management Plan developed for eThekwini as discussed under Section 1.2.1.3.

- *NEDLAC Air Quality Study* – This study investigated the social and economic impact of the phasing out of dirty fuels in the country over a period of time, and aimed to provide specific guidance on supply side measures to support the process.

- *The SO_2 ambient standard setting initiative* – This project was completed in 2002 with the recommended interim guidelines for South Africa by the DEAT (Government Gazette, 21 Dec. 2001)

- *The SABS standard setting approach* - The SABS was engaged to assist the DEAT in the facilitation of the development of ambient air quality standards. A technical committee was established to oversee the development of standards. Three working groups were established by this committee for the drafting of ambient air quality standards for (i) sulphur dioxide, particulates, oxides of nitrogen and ozone, (ii) lead and (iii) volatile organic compounds, specifically benzene. Two documents were produced during the process, viz.:

  SANS 69 - South African National Standard - Framework for setting & implementing national ambient air quality standards

  SANS 1929 - South African National Standard - Ambient Air Quality - Limits for common pollutants

  The latter document includes air quality limits for particulate matter less than 10 μm in aerodynamic diameter (PM_{10}), dustfall, sulphur dioxide, nitrogen dioxide, ozone, carbon monoxide, lead and benzene. The SANS documents were approved by the technical committee for gazetting for public comment. These draft documents were made available for public comment during the May/June 2004 period and were finalized and published during the last quarter of 2004. These limit values as outlined by SANS are proposed as the new ambient air quality standards as published for public comment in the Government Gazette of 9 June 2006.

  Standard methods for ambient air quality monitoring – SANS 1929 provides guidance on macro- and micro-siting of monitoring stations, selection of suitable numbers of stations, data quality objectives, and gives reference methods for measuring pollutant concentrations.

Standard ambient air quality modelling – SANS 1929 provides guidance on the use of atmospheric dispersion modelling for compliance demonstration.

- *The Danida support NAQMP Phase II and IIB Projects* – initiated in April 2004, these projects aimed to develop an NAQM programme and website, train provincial air quality officers, providing an AQA implementation training manual and AQA implementation course. It also aims to develop pollutant prioritisation and standard setting process protocols, and provide the initial list of listed activities, controlled emitters, regulations and an Action Plan Development Manual. Outputs also associated with the projects include AQ information review and AQ Information System framework development.

- *The fuel reformulation initiative* – the DME's cleaner production initiative included the phasing out of leaded fuel by January 2006 and reduction of sulphur content within diesel fuel.

- *The vehicle emissions strategy* – This project is linked to the DME's fuel reformulation initiative.

- *The Norad support licensing capacity development programme* – based on the experience from the Durban South Multipoint Plan. The aim was to develop a draft template for Atmospheric Emissions Licenses that can be used nationally.

- *The Vaal Triangle SEA* – the multi-stakeholder initiative to undertake a strategic environmental assessment of the Vaal Triangle to inform management of priority areas. This process laid the foundation for the current AQO Forum and management initiative for the VTAPA AQMP development process.

- *The APPA Permit Review Pro*ject – the project commenced in January 2005 and will be completed by September 2009. This project included the capturing of all current APPA Registration Certificates into a central database at DEAT. The database was used to sort and assess the various industries and develop a prioritisation matrix from where nine industry sectors were identified for review resulting in a total of 69 individual industries, excluding the almost 200 brickworks. The review included the development of a Registration Certificate template complying with the requirements of the Atmospheric Emissions Licences (AEL) as stipulated in AQA. The revised Registration Certificate was used to test the template and to review the current industries within the various sectors. This project also aimed to capacitate the provincial and local authorities who will be responsible for issuing AELs under AQA. This was done through a series of workshops and a comprehensive manual was drafted to guide local authorities through the licensing process. This project and the manual were reviewed at the DEAT annual Lekgotla held 29-30 September 2008 in Nelspriuit.

- *Project Ferro - AQM enforcement initiatives* – air pollution cases considered serious have been prioritised for enforcement action by the Environmental Management Inspectorate (so-called Green Scorpions).

- *National Framework for Air Quality Management* – according to the Air Quality Act, the Minister must within two years of the date on which this section took effect, establish a national framework for achieving the object of the Act. The project provides the norms and standards to guide air quality management initiatives at national, provincial and local government levels throughout the country. The National Framework is a medium- to long-term plan on how to implement the Air Quality Act to ensure the objectives of the act are met. This project was published under Notice No. 30284 of 11 September 2007.

- *Listed Activities and Minimum Emissions Standard Setting Project* – the minister must in accordance to the act publish a list of activities which result in atmospheric emissions and which is believed to have

significant detrimental effects on the environment and human health and social welfare. The project aims to establish minimum emission limits for all the listed activities identified through a consultative process at several forums. An initial list of activities formed part of the first generation National Framework but has been revised since. The draft Listed Activities and Minimum National Emission Standards was published in February 2008 and is currently with the STANSA Technical Committee for Air Quality for finalisation.

- The *DEAT Ambient Air Quality Monitoring Project* - DEAT has established and commissioned six ambient air quality monitoring stations in the Vaal Triangle Priority Area at the beginning of 2007. The objective of this project was to ensure that air quality management initiatives within the Vaal Airshed are efficiently and effectively identified, prioritised, developed, informed and monitored through, in part, the availability of an effective air quality monitoring network in the area. The monitoring stations are located in Diepkloof (Soweto), Kliprivier, Sebokeng, Sharpville, Three Rivers and Zamdela. With the focus of the new Air Quality Act on human health, these stations were placed in residential areas to determine human health impacts associated with domestic fuel burning, industrial emissions, vehicle emissions as well as trans-boundary pollution impacts from Ekurhuleni Metropolitan Municipality.

- *The residential air pollution initiative* – The DME has embarked on the implementation of the Integrated Clean Household Energy Strategy to reduce the use of biomass burning as energy source in households. This project has three strategic phases, namely:
    - promote the Basa Njengo Magogo (BnM) method of making a fire;
    - manufacturing and distribution of acceptable and affordable low smoke fuel;
    - require housing insulation and energy efficient housing designs

- *Air Quality Management Planning Implementation Manual Project* – this document aims to provide guidance to national, provincial and local government authorities on air quality management planning. The manual establishes best practice guidelines on definition of objectives, strategies, plans and procedures for each sphere of government in order to meet the requirements of AQA on good air quality management planning and reporting. The Draft Manual was completed in June 2008 after consultation with the provincial and local authorities and stakeholders and was launched at the DEAT annual Lekgotla (held 28 & 29 September 2008 in Nelspruit).

- *SAAQIS Project* – SAAQIS aims to provide stakeholders with access to accurate, relevant, current and comprehensive information pertaining to national air and atmospheric quality in order to facilitate informed decision-making with respect to South African ambient air quality objectives. The project initiated in the second half of 2007.

1.3.2 Ambient Air Quality Standards for the Vaal Triangle Airshed Priority Area

Air quality limits and thresholds are fundamental to effective air quality management, providing the indicators to safe exposure levels for the majority of the population. Health based ambient limits have been developed for criteria pollutants internationally and locally. The current South African standards have been revised and were published for comment under Notice No. 528 on 9 June 2006. The newly proposed standards include particulate matter specifically PM_{10} (particulates with a diameter of less than 10 micrometer), sulphur dioxide (SO_2), oxides of nitrogen (NO_x), ozone (O_3), lead, carbon monoxide (CO) and benzene. These revised standards have been adopted as the VTAPA air quality objectives (Table 7). The revised National Ambient Air Quality Standards are undergoing the Standard Setting process and will be published with allowable frequency of exceedances linked to it and compliance timelines provided. The VTAPA air quality objectives do not include allowable frequency of exceedance and will be updated once the new National Standards are published.

Table 7: Ambient Air Quality Limits for Common Pollutants as adopted to be the Air Quality Objectives for the Vaal Triangle Airshed Priority Area.

Substance	10-minute maximum ($\mu g/m^3$)	1-hour maximum ($\mu g/m^3$)	8-hour maximum ($\mu g/m^3$)	24-hour maximum ($\mu g/m^3$)	Annual average ($\mu g/m^3$)
Sulphur dioxide (SO_2)	500	350	-	125	50
Nitrogen dioxide (NO_2)	-	200	-	-	40
Carbon Monoxide (CO)	-	30 000	10 000	-	-
Particulate Matter (PM_{10})	-	-	-	75	40
Ozone (O_3)	-	200	120	-	-
Lead (Pb)	-	-	-	-	0.5
Benzene (C_6H_6)	-	-	-	-	5

1.4 Outline of Report

The report is outlined as follows:

Section 2 - Air quality situation assessment of the Vaal Triangle Airshed Priority Area.
Section 3 - Methodology for the development of an air quality management plan.
Section 4 - Problem identification and objectives analysis.
Section 5 - Strategy analysis and intervention descriptions for the identified problem complexes.
Section 6 - Air Quality Management Plan Implementation Strategy.
Section 7 - Conclusions.
Section 8 - References.

2 VAAL TRIANGLE AIRSHED PRIORITY AREA AIR QUALITY SITUATION ASSESSMENT

2.1 Geographic Overview of the Study Area

Historically the Vaal Triangle included an area stretching from Randvaal in the north to Sasolburg in the southwest and Deneysville in the east. The towns of Vereeniging, Vanderbijlpark and Meyerton fell within this geographic area with various low-income settlements such as Boipatong, Bophelong, Evaton, Orange Farm, Sebokeng, Sharpville and Zamdela.

The population in the VTAPA is approximately 2,532,362 based on the 2001 Census, with the highest population density falling within Soweto and the second highest within the Emfuleni Local Municipality. Both these areas comprise primarily of low income settlements. Most of these households rely on coal and wood for cooking, space heating and lighting purposes.

A mixture of commercial, agricultural, and residential land use activities, all within close proximity to one another, defines the area. In between the urban areas, low intensity farming is practiced. The area is further surrounded by highly populated areas to the north and northeast, specifically the Ekurhuleni Metropolitan Municipality comprising of large industrialised areas (DEAT, 2007).

2.2 Dispersion potential and ambient air quality of the Vaal Triangle Airshed

In order to facilitate the identification of impact areas where local air quality limits are exceeded or are in danger of being exceeded it was necessary to understand the dispersion potential of the priority area, identify and quantify all sources of emissions, and undertake dispersion simulations.

Given the size of the priority area covering approximately 3,600 km^2 the dispersion potential of the site varies. To accommodate these spatial changes in meteorology all meteorological stations located within the priority area were included in the assessment for the period 2004 to 2006. Surface meteorological data was obtained from the South African Weather Service (SAWS) stations in Vereeniging, Johannesburg (OR Tambo Airport) and Springs (falling outside the priority area). In addition, use was made of the meteorological data supplied by various industries in the priority area including Sasol, MSVS and Eskom (only for 2004 since it was decommissioned). Upper air meteorological data was obtained from SAWS ETA data model. The information from these stations was used to simulate a three-dimensional wind field for the study area, taking into account the meteorological and topographical data. The meteorological stations included into the baseline assessment are provided in Figure 2.

The spatial and annual variability in the wind field was evident in the wind roses presented with the stations to the northeast of the priority area (OR Tambo) reflecting primarily northerly winds associated with strong airflow from all directions. The Springs station located to the east-northeast reflected dominant easterly winds and fairly low wind speeds supported by frequent calm conditions. Jabavu, situated in the northern outskirts of the VTAPA, reflected weak winds on average with a slight dominance of northeasterly winds and Orange Farm had generally strong winds primarily from the northwest to west-southwest directions. The Vereeniging station also reflected mainly northwesterly and northerly winds. Grootvlei (located just outside the VTAPA on the eastern side) and ArcelorMittal Steel station (located almost on the same latitude but ~75 km to the west) reflected similar wind fields (prevailing northeasterly and west-southwestly winds). Makalu (was decommissioned at the end of 2004) reflected frequent high wind speeds mainly from the east and north-northwest. The five Sasol stations are all located in close proximity to each other and indicated northwesterly, easterly, and northeasterly winds. Wind speed and wind direction data from the Sasol stations were only available for the last 3 months of 2006. The six DEAT stations have only been operational since the beginning of 2007, falling outside the reflected three-year period (2004 to 2006). The data availability and quality of the two Sedibeng District Municipality stations were poor and therefore omitted from the assessment (DEAT, 2007).

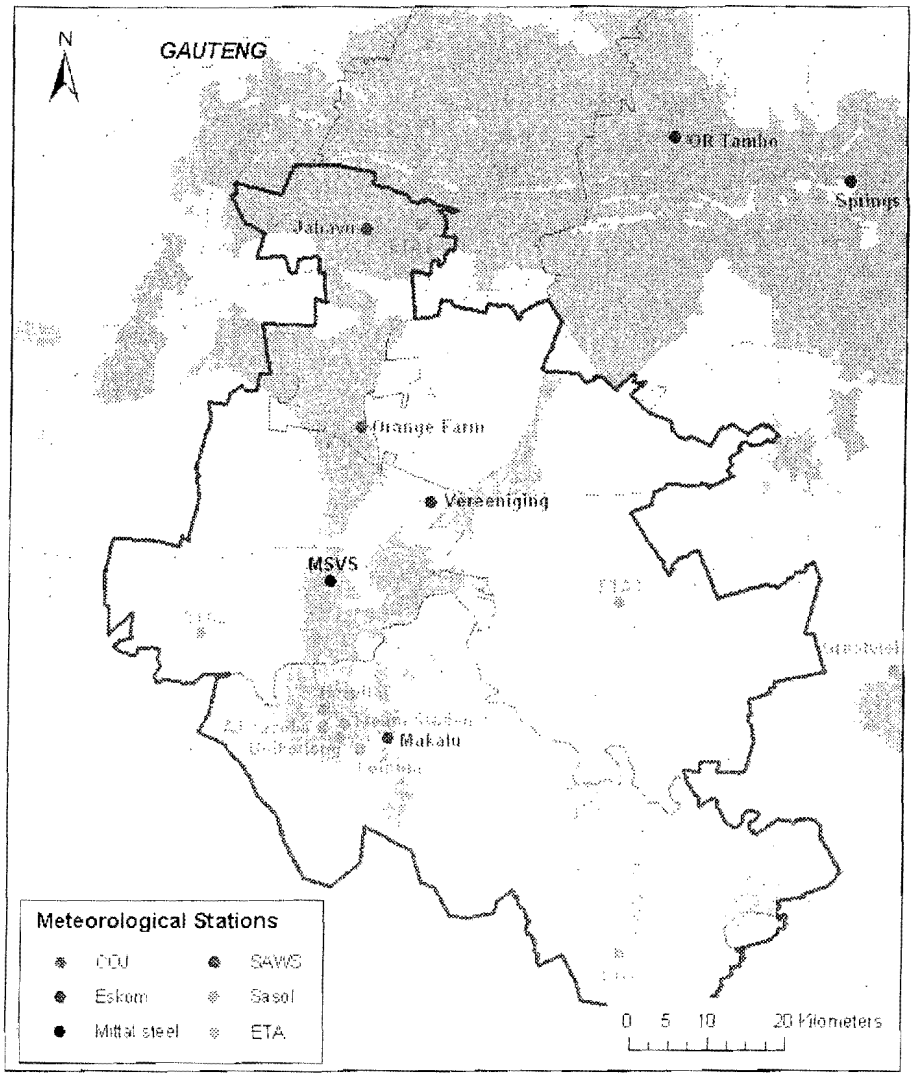

Figure 2: Locations of meteorological stations for which data were obtained.

2.3 Ambient Monitored Air Quality Data within the Vaal Triangle

Ambient monitoring data was obtained from various monitoring stations within the area for the period 2004 to 2006. In the analysis and presentation of the monitoring data, reference was made to the VTAPA ambient air quality targets (also proposed South African Standards) and City of Johannesburg air quality guidelines.

The City of Johannesburg has two operational air quality monitoring stations within the priority area at Jabavu (Soweto) and Orange Farm. These stations have been operational since mid-2004 and are located in domestic fuel burning areas and therefore only measure ambient concentrations of PM_{10} and SO_2. Sedibeng District Municipality has two monitoring stations in Meyerton (Midvaal Local Municipality) and Vanderbijlpark (Emfuleni Local Municipality). The station in Meyerton measures NO_2, NO, NO_x, SO_2, O_3, CO and PM_{10}. The station in Vanderbijlpark is an open path system, which measures NO_2, O_3, SO_2, C_6H_6, pXy and toluene. This station is currently not operational as it is in the process of being transferred to an alternative location in Vanderbijlpark. Data from Sedibeng was not obtained as this is not considered a reliable dataset in terms of data collection and verification.

Ambient monitoring data was limited mainly to industrial sites. Off these, the Eskom Makalu station was decommissioned at the end of 2004. The six DEAT stations that were recently commissioned (between February and March 2007) had very limited data available and this was omitted from the current report. The two stations operated by Sedibeng District Municipality had very poor data availability and quality and could not be used. The two COJ ambient monitoring stations located within the VTAPA provided good quality and available data for the three-year period assessed

Percentage data recovery has been calculated for each station monitoring SO_2, NO_2, PM_{10}, CO and O_3 concentrations for the period 2004 to 2006. Outliers have been removed from the datasets to provide a more representative and accurate dataset. For the City of Johannesburg, recorded data availability was between 63% and 92%. The MSVS stations had fairly poor data availability ranging between 42% and 92%, with the Sasol stations reflecting good data availability of 93% plus. A minimum data capture of 80 % is required to achieve minimum data quality assurance (DEAT, 2007).

2.3.1 PM_{10} Concentrations

Elevated concentrations of PM_{10} concentrations within the Vaal Triangle have been confirmed by various studies conducted over the past 15 years (Tereblanche, 1998., Liebenberg, 1999). Particulate emissions from domestic coal and wood burning have been identified as the major cause of poor ambient air quality in urban areas such as the Vaal Triangle, and have a significant adverse impact on human health. Table 4 provides the measured ambient PM_{10} concentrations in the VTAPA with Table 8 reflecting the number of exceedances of the VTAPA air quality objectives.

Based on the available monitoring data, ambient PM_{10} concentrations are elevated over many areas of the Vaal Triangle, in particular, residential areas where domestic coal burning is occurring and areas neighbouring major industrial operations. These elevated concentrations coincide with periods of low temperatures and stable atmospheric conditions associated with the winter months. Despite the concentrations being highest in residential areas where domestic burning is a major source of energy, the targets are also exceeded from industrial related emissions. The worst-case scenarios occur where industrial and domestic emissions both impact on the ambient PM_{10} concentrations in the area (DEAT, 2007).

Table 8: Number of exceedances of the VTAPA daily PM_{10} target value at all stations over the respective monitoring periods.

Monitoring Agency	Station	PM_{10} Exceedances		
		2004	2005	2006
City of Johannesburg	Jabavu	90	184	154
	Orange Farm	154	182	196
MSVS	Station 620	-	188	24
	Station 350	-	168	56
	Caravan	-	-	180
Sasol	AJ Jacobs	-	-	-
	Boiketlong	-	-	-
	Hospital	-	-	-
	Leitrum	84	162	50
Eskom	Makalu	24	-	-

Note: Exceedances at Jabavu and Orange Farm are based on the COJ daily average PM_{10} air quality guideline of 50 $\mu g/m^3$. The VTAPA target value is75 $\mu g/m^3$.

2.3.2 SO_2 Concentrations

The Vaal Triangle Air Pollution Health Study (Tereblanche, 1998) indicated that SO_2 concentrations exceeded the air quality guidelines (based on the APPA guidelines) for less than 5% of the time in the Sasolburg industrial area, with low concentrations in residential areas. A seasonal trend in SO_2 concentrations was observed, with slightly higher concentrations during winter. A more recent study (Scorgie, 2004) re-evaluated the SO_2 concentrations with the SANS standards indicating SO_2 concentrations in the Sasolburg industrial area exceeded the daily guideline on between 1 and 4% of days. A reduction in SO_2 concentrations in the Sasolburg industrial area was reported although exceedances of the daily average guideline occurred at all Sasol monitoring stations. SO_2 concentrations for the period 2004 to 2006 were evaluated at both residential and industrial areas in the Vaal Triangle in this section. These concentrations are reported in Tables 9, 10 and 11. Table 12 provides the ambient SO_2 concentrations recorded with Table 7 and 8 providing the frequency of exceedance of the daily and hourly standards.

Ambient SO_2 concentrations recorded in the Vaal Triangle currently fall just below the ambient air quality targets. Very few exceedances were recorded at the COJ stations and the Sasol stations. A distinct seasonal signature in SO_2 concentrations is only observed at the residential sites in Jabavu and Orange Farm. The combined influence of low level domestic fuel burning emissions and industrial emissions to ambient SO_2 concentrations in the Vaal Triangle is evident in the diurnal signatures recorded at stations within the region (DEAT, 2007).

Table 9: Highest hourly, daily and annual average PM_{10} concentrations ($\mu g/m^3$) recorded at all monitoring stations from which data was obtained. Exceedances of the VTAPA ambient air quality targets (where applicable) have been highlighted in bold.

Monitoring Agency	Station	Highest Hourly Average			Highest Daily Average			Annual Average		
		2004	2005	2006	2004	2005	2006	2004	2005	2006
City of Johannesburg [1]	Jabavu	785	820	932	**291**	**232**	**215**	-	**88**	**66**
	Orange Farm	996	993	933	**228**	**252**	**233**	-	**78**	**66**
MSVS	Station 620	-	347	217	-	**210**	**125**	-	**103**	**54**
	Station 350	-	376	217	-	**221**	**173**	-	**91**	**52**
	Caravan	-	-	594	-	-	**212**	-	-	**96**
Sasol	AJ Jacobs	-	-	-	-	-	-	-	-	-
	Boiketlong	-	-	-	-	-	-	-	-	-
	Hospital	-	-	-	-	-	-	-	-	-
	Leitrum	999	942	947	**275**	**314**	**294**	**53**	**105**	**41**
Eskom	Makalu	647	-	-	**145**	-	-	34	-	-

Notes: [1] Annual average not calculated for 2004 for Jabavu and Orange Farm monitoring commenced in the second half of 2004

Table 10: Number of exceedances of the VTAPA daily SO_2 target at all stations over the respective monitoring periods.

Monitoring Agency	Station	Daily SO_2 Exceedances		
		2004	2005	2006
City of Johannesburg	Jabavu	0	1	3
	Orange Farm	0	0	6
MSVS	Station 620	0	0	0
	Station 350	0	0	0
	Caravan	-	-	0
Sasol	AJ Jacobs	6	7	9
	Boiketlong	3	8	8
	Hospital	2	3	0
	Leitrum	0	0	0
Eskom	Makalu	0	-	-
Note: Exceedances based on VTAPA air quality SO_2 target (and at Jabavu and Orange Farm are based on the COJ daily average guideline) of 125 $\mu g/m^3$.				

Table 11: Number of exceedances of the hourly VTAPA SO_2 target levels at all stations over the respective monitoring periods.

Monitoring Agency	Station	Hourly SO_2 Exceedances		
		2004	2005	2006
City of Johannesburg	Jabavu	1	2	22
	Orange Farm	11	1	25
MSVS	Station 620	-	5	5
	Station 350	-	3	4
	Caravan	-	-	0
Sasol	AJ Jacobs	53	48	59
	Boiketlong	50	83	91
	Hospital	20	36	18
	Leitrum	5	31	12
Eskom	Makalu	16	-	-
Note: Exceedances based on VTAPA air quality SO_2 target of 350 $\mu g/m^3$.				

Table 12: Highest hourly, daily and annual average SO_2 concentrations ($\mu g/m^3$) recorded at all monitoring stations from which data was obtained. Exceedances of the ambient air quality targets (where applicable) have been highlighted in bold.

Monitoring Agency	Station	Highest Hourly Average			Highest Daily Average			Annual Average		
		2004	2005	2006	2004	2005	2006	2004	2005	2006
City of Johannesburg	Jabavu	400	1359	2031	73	185	148	-	26	27
	Orange Farm	530	1068	2109	107	75	140	-	13	14
MSVS	Station 620	-	512	754	-	114	109	-	37	30
	Station 350	-	697	793	-	110	116	-	28	22
	Caravan	-	-	189	-	-	52	-	-	11
Sasol	AJ Jacobs	751	754	787	270	205	197	39	35	36
	Boiketlong	1864	773	1310	155	182	189	37	41	43
	Hospital	736	665	556	144	164	119	36	33	27
	Leitrum	566	523	665	105	107	113	25	29	31
Eskom	Makalu	623	-	-	124	-	-	20	-	-

2.3.3 Oxides of Nitrogen

The VAPS study noted that NO_x concentrations were low and that no exceedances of the APPA guidelines occurred (Tereblance, 1998). Concentrations were observed to remain relatively constant over most of the region with the exception of the Sasolburg industrial site where an increase was observed. Scorgie (2004) noted a decrease in NO_x concentrations over the period 1990 to 2002 in Sasolburg. This subsection provides an overview of NO_2 concentrations in the Vaal Triangle, based on monitoring data provided by various industries in the region. Table 13 provides the ambient monitoring data for the period 2004 to 2006 with Table 14 indicating the number of hourly exceedances recorded over the same period.

Table 13: Number of exceedances of the VTAPA one hour average NO_2 target level at all stations over the respective monitoring periods.

Monitoring Agency	Station	NO_2 Exceedances		
		2004	2005	2006
City of Johannesburg	Jabavu	-	-	-
	Orange Farm	-	-	-
ArcelorMittal Steel	Station 620	-	0	1
	Station 350	-	0	0
	Caravan	-	-	0
Sasol	AJ Jacobs	-	0	1
	Boiketlong	-	-	-
	Hospital	-	-	-
	Leitrum	5	0	0
Eskom	Makalu	0	-	-

Note: Exceedances based on VTAPA air quality NO_2 target of 200 $\mu g/m^3$.

Based on the available monitoring data received from industries, ambient NO_2 concentrations are low over the monitored areas and do not exceed the COJ ambient air quality guidelines. A distinct seasonal trend in ambient NO_2 concentrations is observed at all the stations, with elevated concentrations during the winter months. The regional scale impact of NO_2 concentrations within the Vaal Triangle is evident in the diurnal trends recorded at the monitoring stations, indicative of a regional source influence and prevailing meteorological conditions (DEAT, 2007).

Table 14: Highest hourly, daily and annual average NO_2 concentrations ($\mu g/m^3$) recorded at all monitoring stations from which data was obtained. Exceedances of the ambient air quality targets (where applicable) have been highlighted in bold.

Monitoring Agency	Station	Highest Hourly Average			Highest Daily Average			Annual Average		
		2004	2005	2006	2004	2005	2006	2004	2005	2006
City of Johannesburg	Jabavu	-	-	-	-	-	-	-	-	-
	Orange Farm	-	-	-	-	-	-	-	-	-
ArcelorMittal Steel	Station 620	-	241.20	293.92	-	63.79	71.46	-	30.78	27.73
	Station 350	-	157.68	134.25	-	67.23	81.40	-	31.25	33.37
	Caravan	-	-	53.96	-	-	36.61	-	-	5.79
Sasol	AJ Jacobs	-	198.46	227.18	-	78.72	87.10	-	28.07	28.07
	Boiketlong	-	-	-	-	-	-	-	-	-
	Hospital	-	-	-	-	-	-	-	-	-
	Leitrum	582.65	143.43	120.81	121.96	57.32	71.61	28.20	23.35	27.03
Eskom	Makalu	100.39	-	-	54.61	-	-	16.21	-	-

2.3.4 Carbon Monoxide Concentrations

Carbon monoxide concentrations were found to be insignificant during VAPS (Tereblanche, 1998) and were not assessed as part of the Legal Resource Centre Air Quality Assessment (Scorgie, 2004). Daily average CO standard has not been established therefore comparison is made with known background concentrations of 200 – 250 ppb (230 - 288 $\mu g/m^3$) (Seinfeld and Pandis, 1998). An overview of CO concentrations recorded in the region is given in Table 16. The CO concentrations in the Vaal Triangle were not considered to be significant.

3.1.5 Ozone Concentrations

Elevated O_3 concentrations have been recorded in the Vaal Triangle in previous studies. Ozone is a secondary pollutant formed when NO_x and Volatile Organic Compounds react in the presence of sunlight. Ambient O_3 concentrations are highest in summer as the intensity of sunlight needed for the photochemical reactions is highest during this time. Table 17 provides the recorded ozone concentrations with the number of exceedances reflected in Table 15 (DEAT, 2007).

Table 15: Number of exceedances of the VTAPA one hour average O_3 target at all stations over the respective monitoring periods.

Monitoring Agency	Station	O_3 Exceedances		
		2004	2005	2006
City of Johannesburg	Jabavu	-	-	-
	Orange Farm	-	-	-
ArcelorMittal Steel	Station 620	-	39	77
	Station 350	-	18	7
	Caravan	-	-	0
Sasol	AJ Jacobs	-	-	-
	Boiketlong	-	-	-
	Hospital	-	-	-
	Leitrum	39	1	16
Eskom	Makalu	0	-	-
Note: Exceedances based on VTAPA air quality O_3 target of 200 $\mu g/m^3$.				

Ambient O_3 concentrations are elevated over parts of the Vaal Triangle, with elevated concentrations during the summer months when high periods of solar radiation promote the formation of O_3. Exceedances of the O_3 one hour average standard were recorded at all stations except Makalu.

Table 16: Highest hourly, daily and annual average CO concentrations ($\mu g/m^3$) recorded at all monitoring stations from which data was obtained. Exceedances of the ambient air quality targets (where applicable) have been highlighted in bold.

Monitoring Agency	Station	Highest Hourly Average			Highest Daily Average			Annual Average		
		2004	2005	2006	2004	2005	2006	2004	2005	2006
City of Johannesburg	Jabavu	-	-	-	-	-	-	-	-	-
	Orange Farm	-	-	-	-	-	-	-	-	-
ArcelorMittal Steel	Station 620	-	11 200	20 100	-	8 900	5 100	-	1 008	1 117
	Station 350	-	6 200	20 100	-	1 900	15 000	-	427	773
	Caravan	-	-	12 400	-	-	1 700	-	-	307
Sasol	AJ Jacobs	-	-	7 150	-	-	1 797	-	-	359
	Boiketlong	-	-	-	-	-	-	-	-	-
	Hospital	-	-	-	-	-	-	-	-	-
	Leitrum	6 670	**26 120**	7 480	1 989	9 307	2 240	362	1 067	447
Eskom	Makalu	-	-	-	-	-	-	-	-	-

Table 17: **Highest hourly, daily and annual average O_3 concentrations ($\mu g/m^3$) recorded at all monitoring stations from which data was obtained. Exceedances of the ambient air quality targets (where applicable) have been highlighted in bold.**

Monitoring Agency	Station	Highest Hourly Average			Highest Daily Average			Annual Average		
		2004	2005	2006	2004	2005	2006	2004	2005	2006
City of Johannesburg	Jabavu	-	-	-	-	-	-	-	-	-
	Orange Farm	-	-	-	-	-	-	-	-	-
ArcelorMittal Steel	Station 620	-	472.85	1 117.8	-	144.16	186.79	-	49.22	62.70
	Station 350	-	600.35	254.41	-	230.99	131.22	-	57.84	70.95
	Caravan	-	-	317.13	-	-	118.38	-	-	24.54
Sasol	AJ Jacobs	-	-	-	-	-	-	-	-	-
	Boiketlong	-	-	-	-	-	-	-	-	-
	Hospital	-	-	-	-	-	-	-	-	-
	Leitrum	429.08	206.09	258.52	108.02	133.53	153.94	63.56	65.17	66.97
Eskom	Makalu	196	-	-	90.26	-	-	41.22	-	-

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2.4 Ambient Air Quality in the Vaal Triangle Airshed

In addition to the ambient monitored data, use was made of dispersion modelling to determine the spatial extend of the ambient concentrations within the VTAPA. This primarily serves the function to establish "hot spot" zones or areas of main concern.

The US.EPA approved CALMET/CALPUFF suite of models was used for the dispersion simulations. CALMET is a diagnostic wind field module that includes parameterized treatments of terrain effects, including slope flows, terrain channelling and kinematic effects, which are responsible for highly variable wind patterns. Data from all the meteorological stations were used for the simulation of the three-dimensional wind field model. CALPUFF is a regional Lagrangian Puff model suitable for application in modelling domains of 50 km to 200 km. Due to its puff-based formulation the CALPUFF model is able to account for various effects, including spatial variability of meteorological conditions, dry deposition and dispersion over a variety of spatially varying land surfaces. The simulation of plume fumigation and low wind speed dispersion are also facilitated. CALPUFF requires as a minimum the input of hourly average meteorological data from the CALMET model in addition to source emissions data.

A first level emissions inventory were developed for the VTAPA based on information obtained from industry and commercial sources, and emissions quantified based on statistics for domestic fuel burning and vehicle fuel consumption within the area (DEAT, 2007).

Thus, the use of these two models in combination provided the required simulated ambient concentrations for the VTAPA.

2.4.1 Assumptions and Limitations

The following limitations and assumptions need to be taken cognisance of for this study:

- Limited background ambient air quality data was available since the DEAT monitoring network has only commenced during February to March 2007. Eskom's Makalu station was decommissioned at the end of 2004 thus providing mainly historical data. The Sasol stations (with the exception of Grootvlei) only had wind speed and wind direction data for the last 3 months of 2006 due to technical problems experienced with the data averaging. Some of the ambient monitoring stations are not SANAS accredited and it was assumed that the data obtained was correct. Ambient monitoring data was mainly limited to criteria pollutants.

- No upper air meteorological data is recorded within the VTAPA with the nearest station located at Irene in Pretoria. Use was made of the South African Weather Services ETA data model results for the required period.

- A questionnaire was compiled for industrial and mining operations requesting all emissions data. A reply of 51% was received from the industries. For the mining operations use was made of information contained in precious Environmental Impact Assessments (EIAs). For the remaining sources of emissions for which no reply was, received 37% could be covered by the NEDLAC Dirty Fuels study or available EIA information. The NEDLAC data is however based on pre-2004 information. Thus, a total of 88% of the identified sources were included into the baseline study with 12% not accounted for. There is however no linear relationship between the percentage sources and the percentage emissions deriving from these sources. Thus, given that it is primarily smaller sources that were not included, the percentage emissions captured are expected to be more than 88%.

- Based on the emissions information available, only criteria pollutants were assessed. These were limited to PM_{10}, SO_2 and NO_x. All industrial sources information was based on pre-2004 to 2006 data.

- Domestic fuel burning emissions were based on 2001 Census data for household coal, wood and paraffin use within the Vaal Priority Airshed. Factors influencing emissions: type of house (formal house, planned / unplanned / backyard shack), whether or not a household is electrified, the number of people living in the house, the season, the availability of fuel types, the price of fuels and the household income. More recent surveys (2004/2005) conducted in Zamdela on the type of energy sources utilised were made available for use by the NOVA Institute. A current survey has been completed by NOVA including information on the number of household using the BnM method but this information will not be available in time for inclusion into the VTAPA AQMP.

- Vehicle emissions were limited to national and regional roads within the VTAPA and the more congested areas within were treated as area sources. Vehicle emissions were calculated using 2006 fuel sales and traffic counts.

2.4.2 Emissions Inventory Compilation

The identification of existing sources of emission in the region and the characterisation of existing ambient pollutant concentrations is fundamental to the assessment of the potential for cumulative impacts and synergistic effects given the existing operations and their associated emissions.

2.4.2.1 Industrial Sources

Significant and potentially significant emitters within the VTAPA are generally grouped within larger industrial sectors within Vanderbijlpark, Vereeniging, Sasolburg and Meyerton. The main contributing sources within these sectors include:

Vanderbijlpark - ArcelorMittal Steel Vanderbijlpark Steel, Vitro Building Products and Davesteel (Cape Gate) as significant sources of particulates. Other potentially significant sources include Africa Cables, Dorbyl Heavy Engineering and Slagment. Potentially significant sources, which have not yet been quantified, include Heckett Multiserve and Ceramic Industries Limited (located next to ArcelorMittal Steel Vanderbijlpark Steel), Sharon Wire Mill, Van Riels Stene and Zeekoeistene. The Ceramic Industry Limited clay quarry to the east of ArcelorMittal was also not accounted for.

Sasolburg - Significant sources of emissions include: the Sasol Chemical Industries Complex, Natref, Omnia Fertiliser, Karbochem, Safripol and Sigma Colliery. The Wonderwater strip-mining operation, which represents a further source of fugitive dust emissions, has not yet been quantified. Sigma and Wonderwater are both Sasol Mining Operations.

Vereeniging - ArcelorMittal Vereeniging (Vaal Works and Klip Works), Rand Water Board and the New Vaal Colliery represent of the most significant sources of particulate emissions. Other sources include Brickveld Stene, SCAW, Coverland Roof Tiles and Lime Distributers. It is anticipated that Vereeniging Refractories and Vereeniging Foundaries would represent significant sources of particulate emissions, although emissions data are not available for these plants.

Meyerton - Based on the emission estimates the largest sources of industrial/mining related emissions within Meyerton include the industries of Metalloys, Blitz Concrete Works and EMSA in addition to various ceramic processes, viz. Ocon Bricks, Vaal Potteries and Meyerton Brick & Tile. African Products are also a significant source within the area. The Glen Douglas Dolomite Quarry is the only known quarrying/mining activity in the area, which could not be quantified due to insufficient available data.

Emissions from the industrial sectors were quantified based on emissions data obtained from industries, data that were already in the public domain and emission estimates from emission factor application. In order to obtain recent emissions data from industry, a detailed questionnaire was compiled and sent out to all identified industries within the VTAPA. The area of interest extended beyond the VTAPA to incorporate industrial activity within the Ekurhuleni Metropolitan Municipality to take into account cross boundary cumulative effects.

The main industry contributing to SO_2 emissions is Power Generation, responsible for 80% of the emissions and secondly Petrochemical contributing 14% to the total with Iron and Steel third (6%). On particulate emissions, the contribution is more equally spread with Iron and Steel being the main industrial contributor (38%) and power generation second at 19% and Petrochemical third (12%). Oxides of nitrogen emissions are primarily a result of Power Generation (73%), Iron and Steel (14%) and Petrochemical (13%) (DEAT, 2007).

2.4.2.2 Domestic Fuel Combustion

Emissions from household fuel combustion were based on the 2001 Census data. A more recent study undertaken by the Bureau of Market Research at UNISA (2006) indicated that the African population for area has increased by between 0.47% and 0.97% from 2001 to 2006. Thus there may be an under prediction for domestic fuel burning of less than 1% based on population predictions. Reference was also made to a study conducted by NOVA on coal burning households in Zamdela during 2003 to 2004.

Quantities of fuels used were estimated on a community-by-community basis and selected emission factors applied to calculate resultant emissions. Emissions were calculated individually for a total of 65 area sources to accurately account for spatial distributions in fuel consumption and hence emissions. Seasonal and diurnal trends in space heating were accounted for based on literature (DEAT, 2007).

2.4.2.3 Mining operations

Mining operations represent potentially significant sources of fugitive dust emissions, with particulate emissions being the main pollutant of concern. Fugitive dust sources associated with colliery and quarry mining activities include materials handling activities, vehicle-entrainment by haul trucks and wind-blown dust from tailings impoundments and stockpiles.

Three mines are operational within the VTAPA namely New Vaal Colliery (in Vereeniging), Sigma Colliery (in Sasolburg) and Glen Douglas Dolomite Quarry (in Meyerton). Sigma and New Vaal Colliery were quantified for the baseline study with no information available for Glen Douglas Dolomite Quarry (DEAT, 2007).

2.4.2.4 Wind-blow Dust from Eskom's Ash Dams and Dumps

The emissions from the various ash dumps within the VTAPA were taken from the Vaal South Environmental Impact Assessment conducted in 2006. Parameters, which have the potential to impact on the rate of emission, include the extent of surface compaction, moisture content, ground cover, the shape of the dam, particle size distribution, wind speed and precipitation.

The location, dimensions and orientations of the ash dumps were taken from recent satellite imagery and topographical maps. Particle size distribution data was obtained from the Matimba ash dump (Scorgie *et al*, 2006).

2.4.2.5 Transport Related Emissions

Emissions as a result of transportations might be a concern within the VTAPA due to the vast distances travelled by commuters between the rural areas and towns, and the busy main route between Gauteng and the Cape Provinces via the Free State. Sources of transport related emissions can be grouped into vehicles (roads); railroad; airport; and shipping. Since there are no harbours within the VTAPA and the airports identified are small with infrequent flights the main focus from transport related sources were vehicle emissions.

Information was obtained from various sources for the priority area. Average percentages of light commercial vehicles and medium and heavy commercial vehicles within the national diesel vehicle fleet were obtained from the NATIS 2005 vehicle population data for Gauteng, Free State, Mpumalanga and the North West Province. Diesel consumption rates were obtained for LCVs, MCVs and HCVs for highveld applications from Stone (2000) and Wong (1999). Annual diesel sales data, obtained from SAPIA per magisterial district for 2006, were used to estimate the total vehicle kilometres travelled using fuel consumption rates suited to each vehicle weight category. Locally developed emission factors published by Stone (2000) were applied taking into account variations in vehicle weight categories (highveld factors).

Vehicle emissions were calculated per magisterial district within the study area by applying vehicle count data for the period 2004 to 2006 to various national and regional routes. The remaining emissions data that could not be assigned to specific routes were then distributed over the remaining regional roads within the VTAPA. In addition, diurnal profile of vehicle activity was taken into account for regional and national routes for which vehicle count data was available (DEAT, 2007).

2.4.2.6 Waste Treatment Facilities

The majority of the waste collected by the local authority is disposed to landfill, usually within 10-20 km radius of the residential areas within which the waste was generated. At present, VTAPA has 12 regional disposal facilities under its jurisdiction. However detailed landfill information could not obtained from the City of Johannesburg and Metsimaholo Local Municipality.

All the *waste disposal sites* within the VTAPA are predominantly used for general waste disposal, including domestic, residential and commercial, business and industrial waste. It was unknown to what extend co-disposal of domestic and industrial/commercial hazardous waste occurs at the general waste sites. Due to the limited information available the emissions from landfill sites could not be quantified.

No information could be obtained on *incinerators* currently operational in the VTAPA. Emission rates from incinerators are a function of fuel usage, waste composition, incinerator design characteristics and operating

conditions. Given the range of pollutants emitted from incinerator operations and the toxic nature of various of such pollutants, it was recommended that incinerators be identified as potential "toxic hotspots" for air quality management needs purposes.

Similarly, no information was available on *waste water treatment works*. Potential emissions of concern resulting from these operations include volatile organic compounds (VOCs). Odour is one of the main effects of water treatment facilities, which may be a serious source of annoyance to the local community, and have been shown in various cases to affect property values and development (DEAT, 2007).

2.4.2.7 Other Sources of Emissions

Crop-residue burning and general wild fires (veld fires) represent significant sources of combustion-related emissions associated with agricultural areas. This is one of the sources not accounted for in the VTAPA, which is regarded as a significant source of emissions (specifically particulates).

Agricultural activities are also a large source of particulate emissions. There are numerous farms and small holdings in the VTAPA with about 60% of the area of the region being occupied by agricultural activities including field cultivation and pastoral farming.

Sources of *spontaneous combustion* are also regarded as potential significant sources of SO_2 and particulates. The risk of spontaneous combustion can be minimised by ensuring stockpiles are properly compacted and discard is covered with non-combustible material as soon as possible after placement (DEAT, 2007).

2.4.2.8 Synopsis of Emissions

Emissions from industrial operations, open cast coal mines and ash dumps, vehicle exhaust emissions and residential fuel burning were estimated and are provided in Table 18.

Table 18: Emission estimates from the various source groups within the VTAPA and immediate surrounding areas.

Sector	Emissions in tpa		
	SO_2	NO_x as NO_2	PM_{10}
Industries	215 865	168 672	25 450
Commercial	40	25	47
Mines and Ash Dumps	0	0	4 554
Vehicles	2 014	110 029	5 078
Domestic Fuel Burning	3 442	2 093	1 904
TOTAL	**221 361**	**280 819**	**37 033**

Based on the emissions inventory compiled for the VTAPA, the main sources contributing to SO_2 emissions within the area are the power generation sources (78%) and industrial sources (20%) with vehicle exhaust and domestic fuel burning contributing to a lesser extent of 1% and 1.6% respectively (see Figure 3).

The main contributors of NO_x emissions are provided in Figure 4. Vehicle exhaust emissions were the main contributing source (45%) with power generation contributing 39% and other industries contributing 16% (see Figure 4).

Particulate (PM_{10}) emissions, when looked at the total suspended particulates, are mainly deriving from the industrial sector (53%) and then from the power generation (16%), vehicle activity (14%) and mines (12%). Domestic fuel burning only contributes 5% to the total inhalable particulate matter. This is reflected in Figure 5.

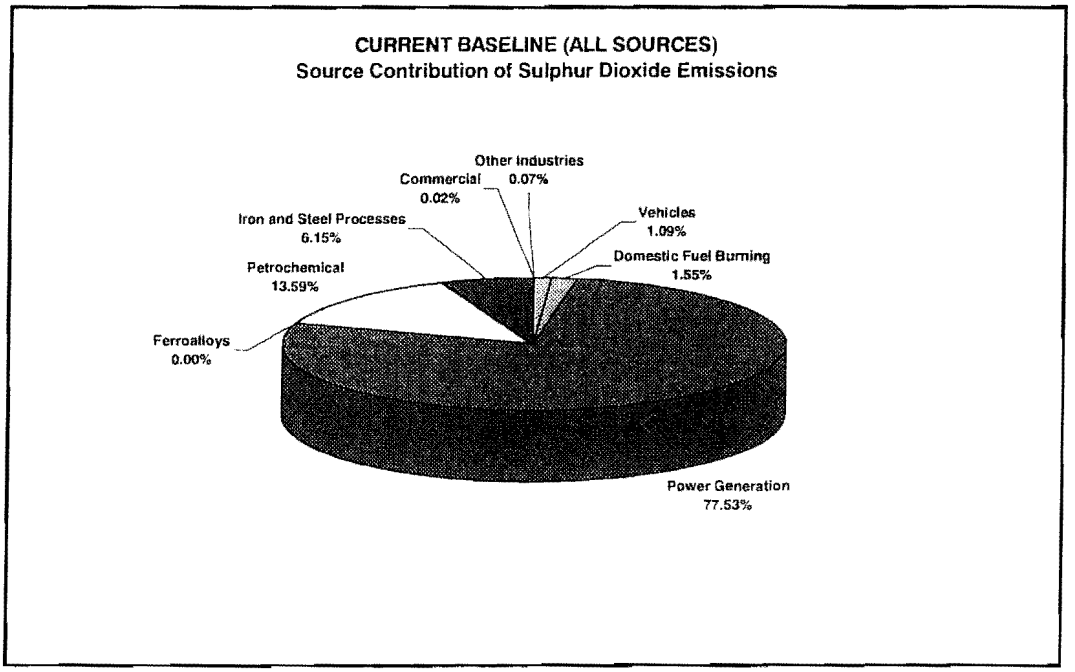

Figure 3: Total annual sulphur dioxide emissions from all quantifiable sources within the VTAPA.

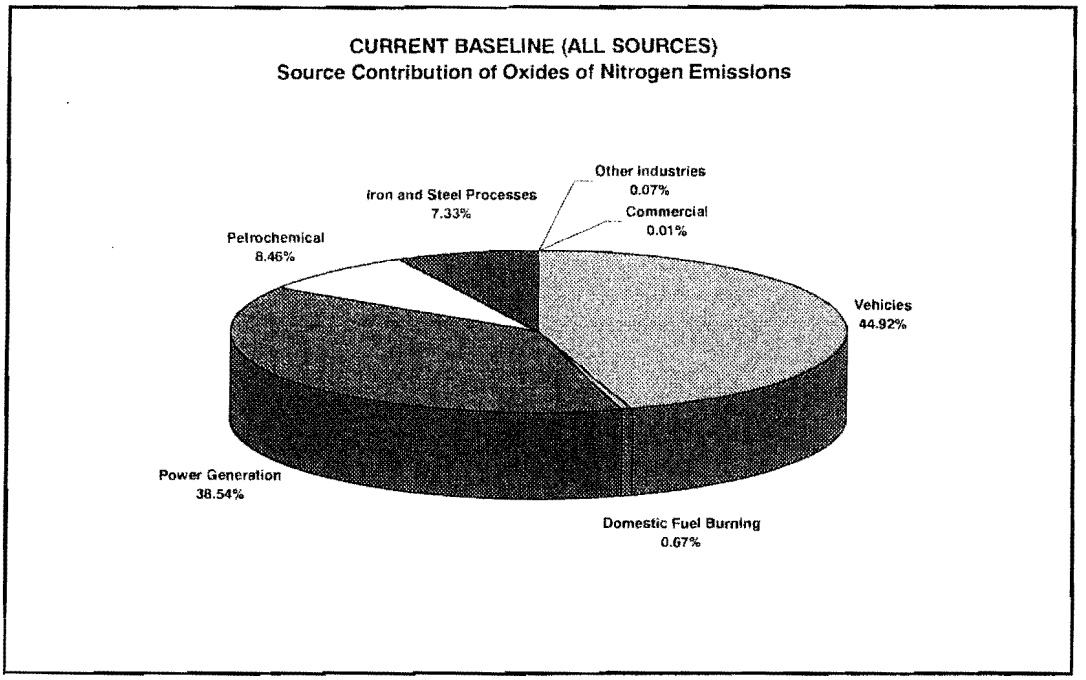

Figure 4: Total annual oxides of nitrogen emissions from all quantifiable sources within the VTAPA.

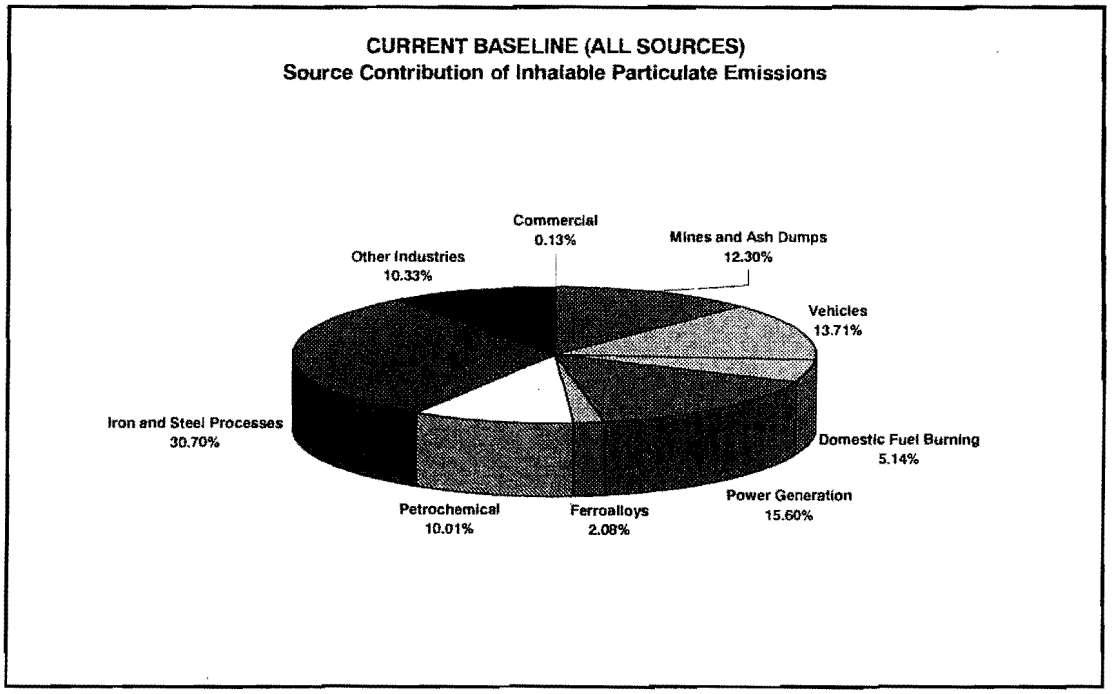

Figure 5: Total annual inhalable particulate emissions from all quantifiable sources within the VTAPA.

2.4.3 Predicted Ground Level Baseline Concentrations

Dispersion models compute ambient concentrations as a function of source configurations, emission strengths and meteorological characteristics, thus providing a useful tool to ascertain the spatial and temporal patterns in the ground level concentrations arising from the emissions of various sources. CALMET and CALPUFF in combination provided a simulation tool capable of treating many important complex terrain effects, including spatial variability of the meteorological fields, curved plume trajectories, and plume-terrain interaction effects. Maximum hourly average, maximum daily average and annual average concentrations were simulated through the application of CALPUFF, using as input the relevant emissions data and the three-dimensional CALMET data set. CALPUFF allows for first order chemical transformation modelling determining gas phase reactions for SO_x and NO_x.

The meteorology was modelled and the dispersion of pollutants simulated for the entire area covering ~120 km (east-west) by 135 km (north-south), with ambient ground-level concentrations and deposition levels being predicted for over 16 200 receptor points.

Comparisons between CALPUFF results, and results generated by the Industrial Source Complex Model Short Term version 3 (ISCST3) model, have shown that CALPUFF is generally more conservative. CALPUFF predictions have been found to have a greater correlation with observations, with predictions generally within a factor of two of the observations (DEAT, 2007).

2.4.3.1 Comparison between Ambient Predicted Concentrations and Measured data

Simulations were undertaken to determine particulate matter (PM_{10}), sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) concentrations within the VTAPA due to all quantifiable sources of emissions. Predicted results provided as a comparison to measured results are listed in Tables 19, 20 and 21 for SO_2, NO_2 and PM_{10} respectively.

Modelled SO_2, NO_2 and PM_{10} *concentrations* simulated for current baseline conditions within the VTAPA were compared to monitored concentrations (where data availability was >80%). The predicted ground level concentrations compared well with ambient measured SO_2 levels for all averaging periods with the exception of the Sasol stations. The predicted concentrations at the Sasol stations compared well for highest hourly and daily averaging periods but under predicted on an annual averaging period. Modelled NO_2 concentrations compared generally well for highest hourly and daily averaging periods but under predicted for annual averaging periods for all monitoring stations. At *Orange Farm*, the predicted PM_{10} ground level concentrations compared well to monitored data for highest hourly and daily ground level concentrations, but under predicted on an annual averages. The predicted PM_{10} concentrations at the *Leitrum* monitoring station were comparative to monitored data with the exception of the annual averaging period of 2005. Predicted ground level concentrations at *Makalu* correlated well for all averaging periods and for all pollutants.

In general, a good correlation was found between modelled and monitored concentrations for the short and medium term exposures. This confirmed that the model interpreted the zones of impact correctly and the concentrations related to short-term health exceedance impacts. Over the long term (annual averages), the ground level concentrations were generally under predicted due to sources that could not be accounted for in the current study. These sources would include agricultural activities and biomass burning as well as sources outside the study area that will have an impact within the VTAPA due to trans-boundary transportation of pollutants (DEAT, 2007).

Table 19: Comparison of monitored and modelled SO_2 ground level concentrations for current baseline conditions within the VTAPA.

Monitoring Agency	Station	Highest Hourly Average			Highest Daily Average			Annual Average		
		2004	2005	2006	2004	2005	2006	2004	2005	2006
Measured SO_2 (µg/m³)										
City of Johannesburg	Orange Farm		237	395		35	64		13	15
ArcelorMittal Steel	Station 620			472			69			30
	Station 350		398			61			28	
Sasol	AJ Jacobs	546	701	621	109	104	110	39	36	37
	Boiketlong	515	664	1285	92	111	104	37	41	38
	Hospital	639	633	479	84	84	81	36	33	27
	Leitrum	477	461	947	70	78	153	26	31	32
Eskom	Makalu	581			59			20		
Modelled SO_2 (µg/m³)										
City of Johannesburg	Orange Farm	342	272	230	56	44	48	10	8	9
ArcelorMittal Steel	Station 620	457	430	389	86	128	111	20	22	23
	Station 350	432	366	406	64	44	48	20	18	20
Sasol	AJ Jacobs	609	688	626	63	65	64	12	7	10
	Boiketlong	498	444	696	61	44	56	13	11	11
	Hospital	453	296	669	53	47	54	10	6	8
	Leitrum	717	509	768	101	61	60	21	20	19
Eskom	Makalu	575	515	474	45	41	60	10	10	11
Ratio between Measured and Modelled SO_2 Concentrations										
City of Johannesburg	Orange Farm		1.1	0.6		1.2	0.7		0.6	0.6
ArcelorMittal Steel	Station 620			0.8			1.6			0.8
	Station 350		0.9			0.7			0.6	
Sasol	AJ Jacobs	1.1	1.0	1.0	0.6	0.6	0.6	**0.3**	**0.2**	**0.3**
	Boiketlong	1.0	0.7	0.5	0.7	**0.4**	0.5	**0.3**	**0.3**	**0.3**
	Hospital	0.7	0.5	1.4	0.6	0.6	0.7	**0.3**	**0.2**	**0.3**
	Leitrum	1.5	1.1	0.8	1.4	0.8	**0.4**	0.8	0.6	0.6
Eskom	Makalu	1.0			0.8			0.5		

Table 20: Comparison of monitored and modelled NO_2 ground level concentrations for current baseline conditions within the VTAPA.

Monitoring Agency	Station	Highest Hourly Average			Highest Daily Average			Annual Average		
		2004	2005	2006	2004	2005	2006	2004	2005	2006
Measured NO_2 ($\mu g/m^3$)										
ArcelorMittal Steel	Station 620			274			48			28
	Station 350		140			55			29	
Sasol	AJ Jacobs		181	161		63	54		28	28
	Leitrum	177	144	117	68	48	51	28	23	27
Eskom	Makalu	95			33			16		
Modelled NO_2 ($\mu g/m^3$)										
ArcelorMittal Steel	Station 620	291	124	296	31	22	21	6	5	6
	Station 350	145	130	169	26	23	26	6	5	6
Sasol	AJ Jacobs	256	149	243	31	25	25	6	4	4
	Leitrum	200	287	136	40	28	21	8	7	7
Eskom	Makalu	172	186	212	26	17	32	6	6	6
Ratio between Measured and Modelled NO_2 Concentrations										
ArcelorMittal Steel	Station 620			1.1			**0.4**			**0.2**
	Station 350		0.9			**0.4**			**0.2**	
Sasol	AJ Jacobs		0.8	1.5		**0.4**	0.5		**0.1**	**0.2**
	Leitrum	1.1	2.0	1.2	0.6	0.6	**0.4**	**0.3**	**0.3**	**0.2**
Eskom	Makalu	1.8			0.8			**0.4**		

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Table 21: Comparison of monitored and modelled PM_{10} ground level concentrations for current baseline conditions within the VTAPA.

Monitoring Agency	Station	Highest Hourly Average			Highest Daily Average			Annual Average		
		2004	2005	2006	2004	2005	2006	2004	2005	2006
Measured PM_{10} ($\mu g/m^3$)										
City of Johannesburg	Orange Farm	979	929	933	154	176	152		78	66
Sasol	Leitrum	998	905	947	168	254	153	53	105	41
Eskom	Makalu	605			97			34		
Modelled PM_{10} ($\mu g/m^3$)										
City of Johannesburg	Orange Farm	770	526	558	133	84	99	15	12	12
Sasol	Leitrum	1051	1014	1174	171	130	135	36	25	29
Eskom	Makalu	479	494	726	87	75	69	20	18	18
Ratio between Measured and Modelled PM_{10} Concentrations										
City of Johannesburg	Orange Farm	0.8	0.6	0.6	0.9	0.5	0.6		**0.2**	**0.2**
Sasol	Leitrum	1.1	1.1	1.2	1.0	0.5	0.9	0.7	**0.2**	0.7
Eskom	Makalu	0.8			0.9			0.6		

2.4.3.2 Predicted Ambient Concentrations

Predicted air pollutant concentrations and frequencies of exceedance due exclusively to current conditions are summarised in Table 22.

Table 22: Predicted maximum air pollutant concentrations due to all source activity within the VTAPA based on 2004, 2005 and 2006 meteorological conditions.

Pollutant	Averaging period	Maximum Concentrations (µg/m³) &	VTAPA Ambient Air Quality Target (µg/m³)	Predicted Concentrations as a fraction of the target	Frequency of Exceedance (d)
Sulphur Dioxide (SO_2) (a)	Calculated 10-minute Average	1545	500	**3.09**	N/A
	Highest Hourly Average	1080	350	**3.09**	125
	Highest daily average	243	125	**1.94**	33
	Annual Average	55	50	**1.10**	N/A
Oxides of Nitrogen (NO_x) (b)	Highest Hourly Average	689	200	**3.44**	388
PM_{10} (c)	Highest daily average	7412	75	**98.83**	354
	Annual Average	978	40	**24.46**	

Notes:
(a) The maximum SO_2 pollutant concentrations occur in the vicinity of Orange Farm
(b) The maximum NO_x pollutant concentrations occur in the northern suburbs of Vanderbijlpark
(c) The maximum PM_{10} pollutant concentrations occur in the vicinity of Sebokeng
(d) Reflected as number of hours per year or number of days per year where the relevant target was exceeded.

The main findings were as follows:

- **Sulphur dioxide (SO_2)** - *Sulphur dioxide short-term targets* are significantly exceeded due to current emitting sources in terms of the magnitude, frequency and spatial extent of exceedance.

- **Nitrogen dioxide (NO_2)** - Ambient *hourly NO_2* target exceedances occur mainly over the built up areas of the VTAPA (numbers of occurrences, however, are generally within those permitted by the EC of eight times per year).

- **Particulate Matter (PM_{10})** – Ambient *PM_{10} daily targets* are significantly exceeded due to current emitting sources in terms of the magnitude, frequency and spatial extent of exceedance.

The main conclusion reached was that ***current baseline emissions are associated with significant non-compliance with relevant ambient sulphur dioxide and inhalable particulate matter (PM_{10}) target levels***. Ambient NO_2 concentrations exceeded the hourly target levels over the built up areas of the VTAPA. The occurrences of these hourly exceedances were however, generally infrequent (<8 hours during the period) (DEAT, 2007).

2.5 Air quality management practices and initiatives within National, Provincial and Local Government

The capacity for air quality management and control within the Vaal Triangle Priority Area was assessed within the various spheres of Government. The current capacity at National, Provincial, Metropolitan, District and Local levels was evaluated in terms of available personnel, functions and resources.

2.5.1 National Government

Within DEAT, the Chief Directorate of Air Quality Management and Climate Change is responsible for air quality related functions. Within this Chief Directorate, the Directorate of Atmospheric Policy, Regulation and Planning and the Directorate of Air Quality Management have a direct role in VTAPA and future identified priority areas is the responsibility of the Priority Area Management sub-directorate. This sub-directorate is responsible for the development of the Vaal Triangle Priority Area Air Quality Management Plan and will need to ensure the adoption and implementation of this Plan in the Vaal Triangle Area.

2.5.2 Provincial Government

Two provinces are included in the VTAPA, namely Gauteng and the Free State. In the Gauteng Province, the Directorate of Air Quality is responsible for air quality management within the Gauteng Department of Agriculture, Environment and Conservation. Functions of this Directorate are not only dedicated to air quality management but also include environmental management components. Responsibility for air quality management within the Free State Province lies with the Air Quality Management Sub Directorate within the Directorate of Environmental Quality. Capacity for air quality management within the Free State is limited as air quality related functions are the responsibility of one official within the sub-directorate.

2.5.3 Local Government

The local authorities covered by the VTAPA include the Metropolitan Municipality of Johannesburg, the District Municipalities of Sedibeng and Fezile Dabi, and the Local Municipality of Emfuleni.

Ambient air quality management and control at the Metropolitan Level is a function of the Departments of Environmental Management and Health within the City of Johannesburg. The City of Johannesburg was the first municipality to develop an Air Quality Management Plan in 2005. The plan is currently being revised.

Within Sedibeng District Municipality, Environmental Health Services is responsible for air quality management and control, in which the Environmental Health Practitioners undertake air quality related functions. Within Fezile Dabi District Municipality, air quality management is the responsibility of the Environmental Health Practitioners. Environmental and air quality related functions at this District are the responsibility of Municipal Health Services. Current functions are limited to the investigation of air quality complaints from the public.

Environmental Health Practitioners are responsible for air quality related functions at the local level in Emfuleni Local Municipality. These functions include a complaints response database, the periodic inspection of boilers and a current database of fuel burning appliances in the area. Basic maintenance (changing of filters, housekeeping) of the monitoring station in Vanderbijlpark is undertaken by Emfuleni Local Municipality.

2.5.4 Air Quality Management Tools

Within the different Municipalities, complaints received from the public are manually logged into a book and investigated by the Environmental Health Practitioners.

Even no emissions inventory database currently exists at the Provincial level, an emissions inventory database will be compiled as part of the proposed Air Quality Management Plans for Gauteng and Free State. The City of Johannesburg Metropolitan Municipality is the only Municipality to have a comprehensive emissions inventory database. At the District level, Sedibeng has initiated the process to develop an emissions inventory with Emfuleni having a database of fuel burning appliances.

Limited software and knowledge exists within each sphere of Government to support dispersion modelling. The City of Johannesburg is the only Municipality, which has the required personnel and software (ADMS Urban) to undertake dispersion modelling in Gauteng (DEAT, 2007).

2.6 Conclusions

2.6.1 Priority Pollutants within the VTAPA

The pollutants of concern within the VTAPA are the criteria pollutants of SO_2, PM_{10} and NO_2. Based on the available monitoring data, the major findings of the air quality assessment indicate that:

- ***Particulate (PM_{10})*** concentrations are elevated over most areas of the VTAPA, particularly in residential areas where domestic coal burning is occurring and areas neighbouring major industrial operations.
- ***Sulphur dioxide (SO_2)*** concentrations are generally below the VTAPA air quality objectives in both the residential and industrial stations, although exceedances were recorded on several occasions at Jabavu and Orange Farm and in Sasolburg.
- ***Nitrogen dioxide (NO_2)*** concentrations are low in the VTAPA, although a seasonal signature is observed in NO_2 concentrations. Nitrogen dioxide concentrations have a regional impact within the Vaal Triangle.
- ***Carbon monoxide (CO)*** concentrations are not considered to be significant in the VTAPA.
- ***Ozone (O_3)*** concentrations are elevated in areas surrounding major industrial operations with exceedances of the one-hour average target recorded on numerous occasions. Ozone concentrations measured at Makalu are representative of known background concentrations in South Africa.

2.6.2 Priority Sources within the VTAPA

Sources within the VTAPA include a wide range of industries; a coal fired power station; household coal and wood combustions; vehicle emissions; filling stations, brickworks; mining operations and other sources such as waste disposal facilities; fugitive dust sources and biomass burning.

All of these sources to a larger and lesser extend contribute to particulates (PM_{10}), with most of the industrial sources, the domestic fuel burning, vehicle tailpipe emissions contributing to SO_2 and NO_2.

2.6.3 Priority Areas

Priority areas or hotspot zones where intervention strategies will take priority have been identified based on the predicted ambient air concentrations from the priority pollutants and exposure potential.

The prioritisation of sources has been ranked based on impacts rather than the extent of their emissions. This ensures that the main contributing sources resulting in non-compliance with the VTAPA ambient air quality targets and hence pose the greatest risk to human health and the environment, be addressed as priority. In addition, this will clearly define the problems and subsequently inform the intervention strategies to be determined.

In order to determine the significance of the areas where the ambient air quality standards or VTAPA ambient air quality objectives were exceeded, the predicted contours were superimposed onto the population density (based on 2001 Census). A synopsis of the findings of this analysis is presented in Table 23 for PM_{10}, SO_2 and NO_2.

From predicted ground level concentrations through dispersion modelling, verified with ambient monitored data, the main pollutant of concern within the VTAPA is inhalable particulates (PM_{10}). Six priority areas were identified within the VTAPA based on highest PM_{10} concentration zones or "hotspots" (Figure 6). 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 emissions sources and main pollutants of concern are provided in Table 24 for each of the identified priority zones (DEAT, 2007).

Table 23: Number of people residing in non-compliance areas within VTAPA exposed to SO_2, PM_{10} and NO_2 concentrations

Source Group	No. of Persons Residing within VTAPA Predicted to Exceeded Air Quality Targets			
	Single Exceedance SO_2 hourly 350 µg/m³ Target	Single Exceedance of SO_2 daily 125 µg/m³ Target	Single Exceedance of NO_2 hourly 200 µg/m³ Target	Single Exceedance of PM_{10} daily 75 µg/m³ Target
All quantifiable sources	1,048,515	137,708	807,842	1,484,841
Household fuel burning	452,080	109,688	-	186,010
Vehicle exhaust	-	-	-	-
Industry	543,422	-	722,719	403,108
Mines	-	-	-	119,398

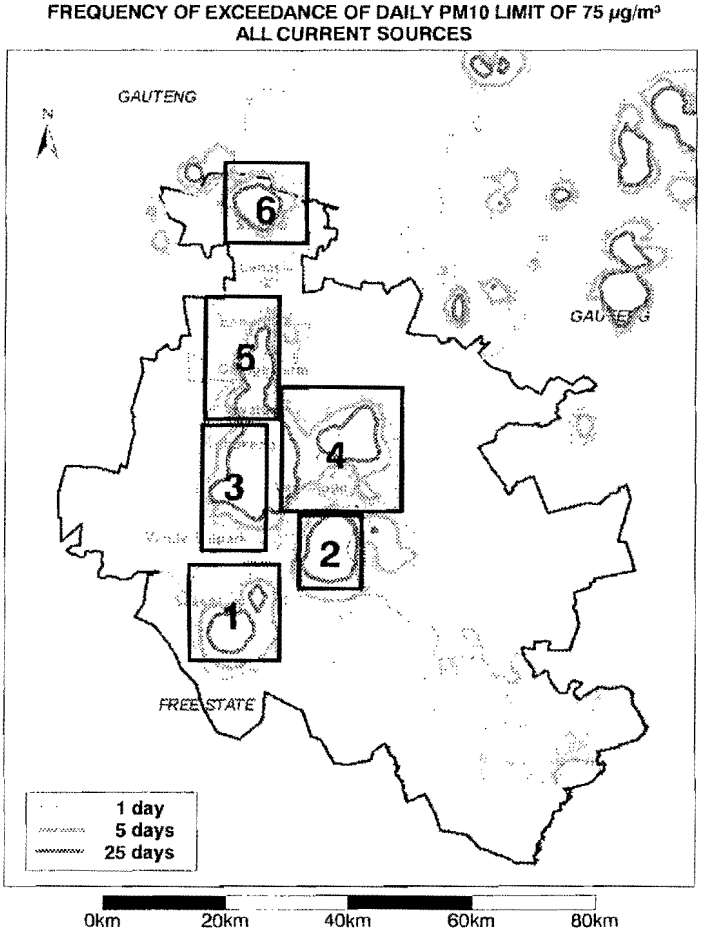

Figure 6: Six priority "hotspot" areas identified within the VTAPA based on predicted PM_{10} ground level concentrations.

Table 24: 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	Figure indicating Hotspot Zone
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	Figure 7
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,	Figure 8
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 (viz. a ceramics manufacturing facility, a brickworks and a quarry), water treatment works, biomass burning and agricultural activities	PM_{10}, SO_2, NO_2 and odours, Ozone, VOCs	Figure 9
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	Figure 10
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	Figure 11
6	Residential area of Soweto	Domestic fuel burning	Wind blown dust from gold tailings dams	PM_{10}, SO_2 and NO_2, VOCs	Figure 12

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The contributing emission sources as well as the long-term ground level concentrations per priority "hotspot" zone have been identified. The sources identified as contributing to ambient air quality consists of industrial activities, mining activities, domestic fuel burning and vehicle activities (DEAT, 2007).

The impacts per hotspot zone are as follows:

- At priority "hotspot" zone 1, the main sources of emissions are petrochemical processes. For SO_2, NO and NO_2 petrochemical processes contribute more than 90% of the emissions. For PM_{10} emissions within the area, petrochemical processes contribute 70% and mining activities 18%. The main contributors of SO_2, NO_2 and NO ground level concentrations in ranking order is a combination of petrochemical processes, power generation, iron and steel processes and domestic fuel burning. For PM_{10} impacts the main contributing source is mining operations (>86%).

- For priority "hotspot" zone 2, emissions are due primarily to power generation and mining activities in terms of PM_{10}. Annual average ground level concentrations for SO_2 and NO_2 are mainly from a combination of iron and steel processes, power generation, petrochemical processes and domestic fuel burning. NO ground level concentrations resulted mainly from iron and steel processes and power generation with PM_{10} concentrations occurring due to small industries, fertilizer processes and mining activities.

- Priority "hotspot" zone 3 is situated in an area of elevated industrial activity. The main sources of emissions are from iron and steel processes, vehicle activity contributing 47% of the NO_2 and other industries in the area contributing 20% of PM_{10}. For SO_2, NO and NO_2 ground level concentrations, the main contributing sources in ranked order are iron and steel processes and then a combination of power generation, petrochemical processes and domestic fuel burning. For PM_{10}, the main sources of annual ground level concentrations are iron and steel processes (50%) and other smaller industrial activities (45%).

- The main sources of emissions within the priority "hotspot" zone 4 are vehicles for the contribution of SO_2, NO and NO_2. For PM_{10} emissions the main contributing sources consist of smaller industrial activities (49%) and ferroalloy processes (39%). NO_2, NO and SO_2 annual ground level concentrations are due mainly to iron and steel processes with a combination of petrochemical processes, power generation, domestic fuel burning and vehicle activity (for oxides of nitrogen only) contributing to a lesser extent. The PM_{10} impacts are due mainly to (in ranking order), smaller industrial activities, ferroalloy processes, iron and steel processes and mining activities.

- Priority "hotspot" zone 5 consists of a lower income population group with the main source of PM_{10} and SO_2 emissions being domestic fuel burning. Vehicle tailpipe emissions contribute <70% of the NO and NO_2 emissions in the area. The main source of long-term ground level concentrations are from domestic fuel burning for NO, SO_2, and PM_{10} (>90%). NO_2 ground level concentrations are made up of domestic fuel burning (58%), and to a lesser extent iron and steel processes (21%), power generation (9%), petrochemical processes (7%) and vehicle exhaust (5%).

- Priority "hotspot" zone 6 is situated in an area of domestic fuel burning and vehicle activity. Long-term ground level concentrations are therefore mainly due to domestic fuel burning contributing >87% for SO_2 and PM_{10}, 28% for NO and 32% for NO_2. Other sources contributing to annual ground level concentrations are vehicle activity (72% for NO, 59% for NO_2 and 10% for PM_{10}).

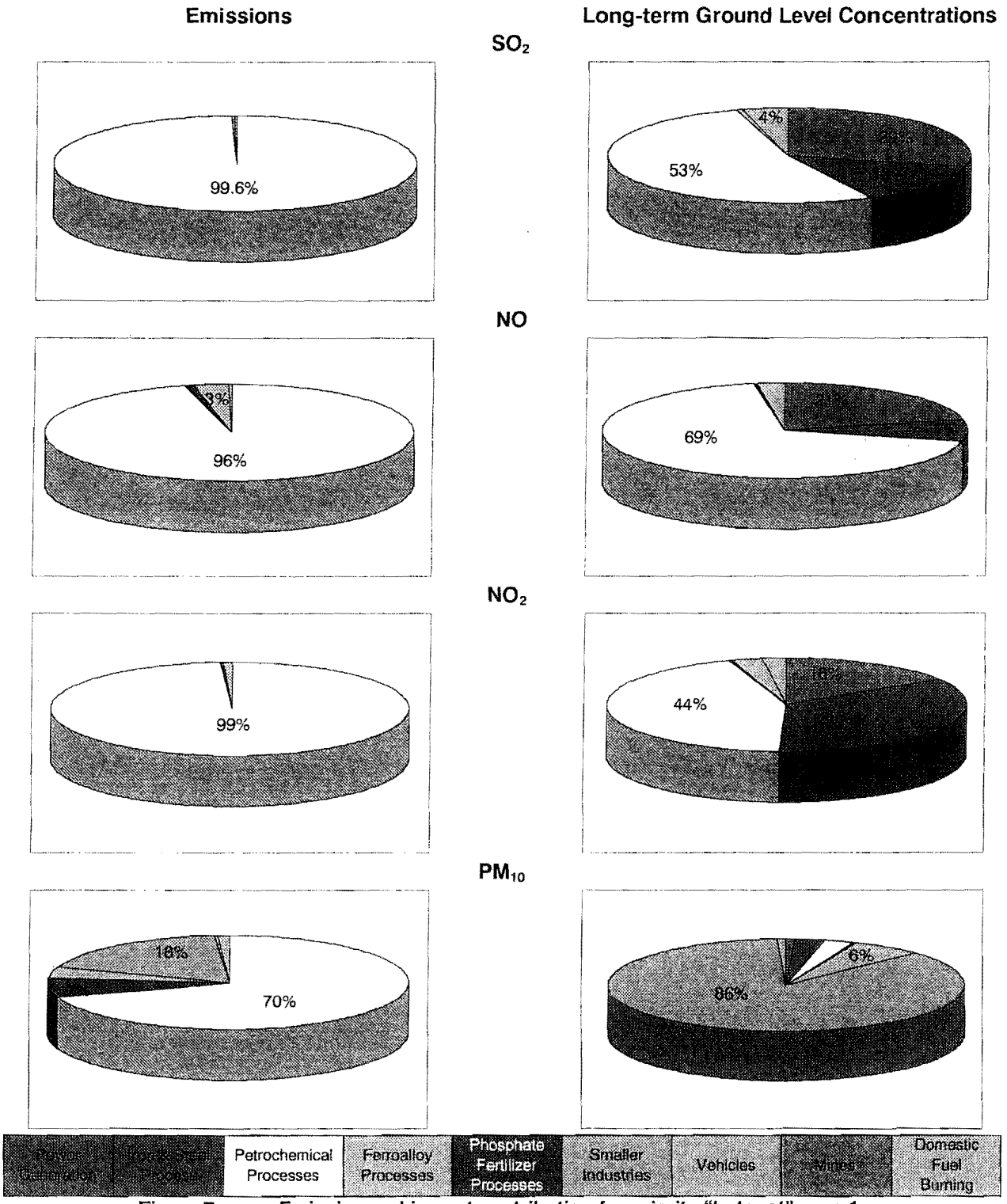

Figure 7: Emission and impact contribution for priority "hotspot" zone 1.

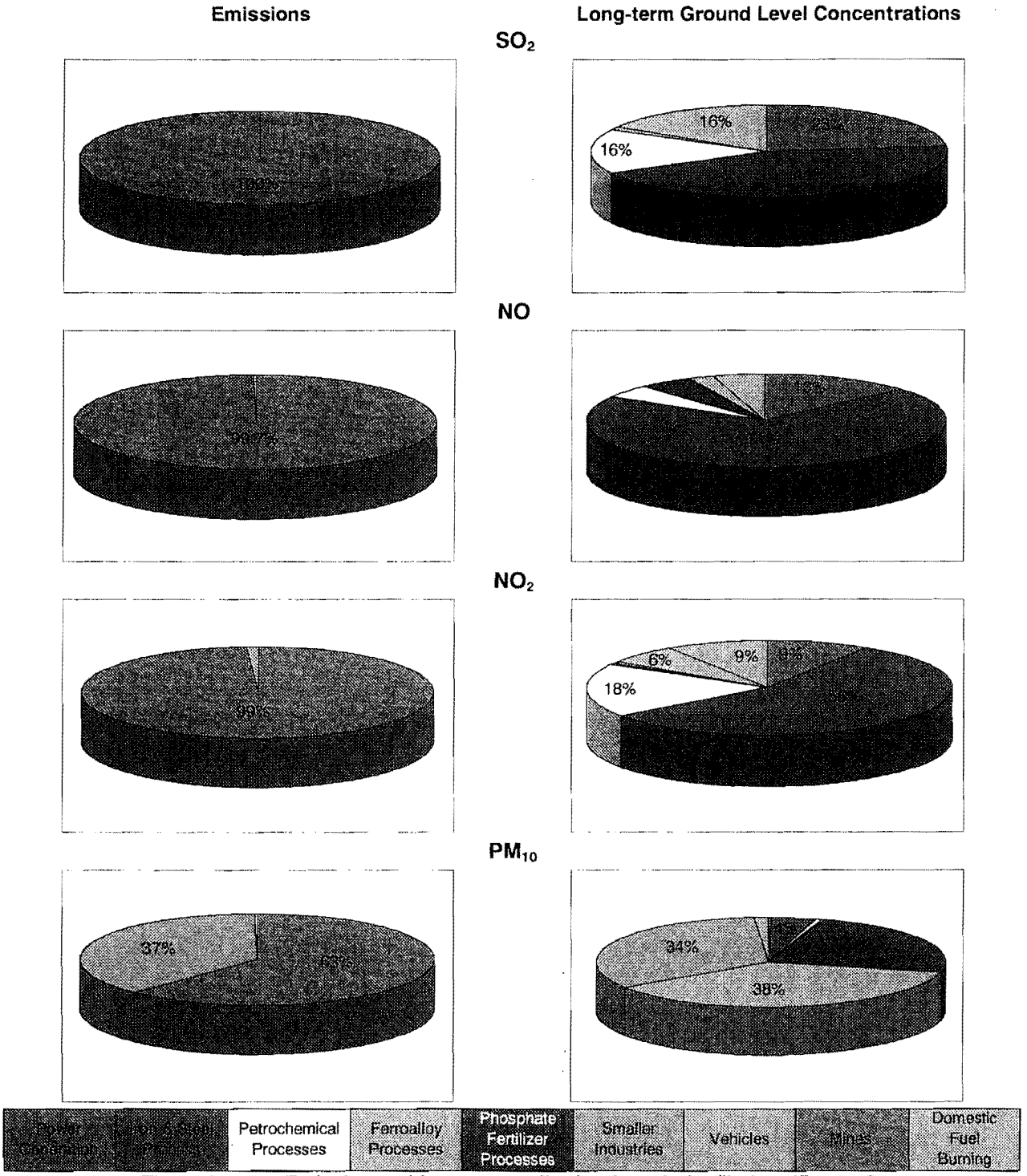

Figure 8: Emission and impact contribution for priority "hotspot" zone 2.

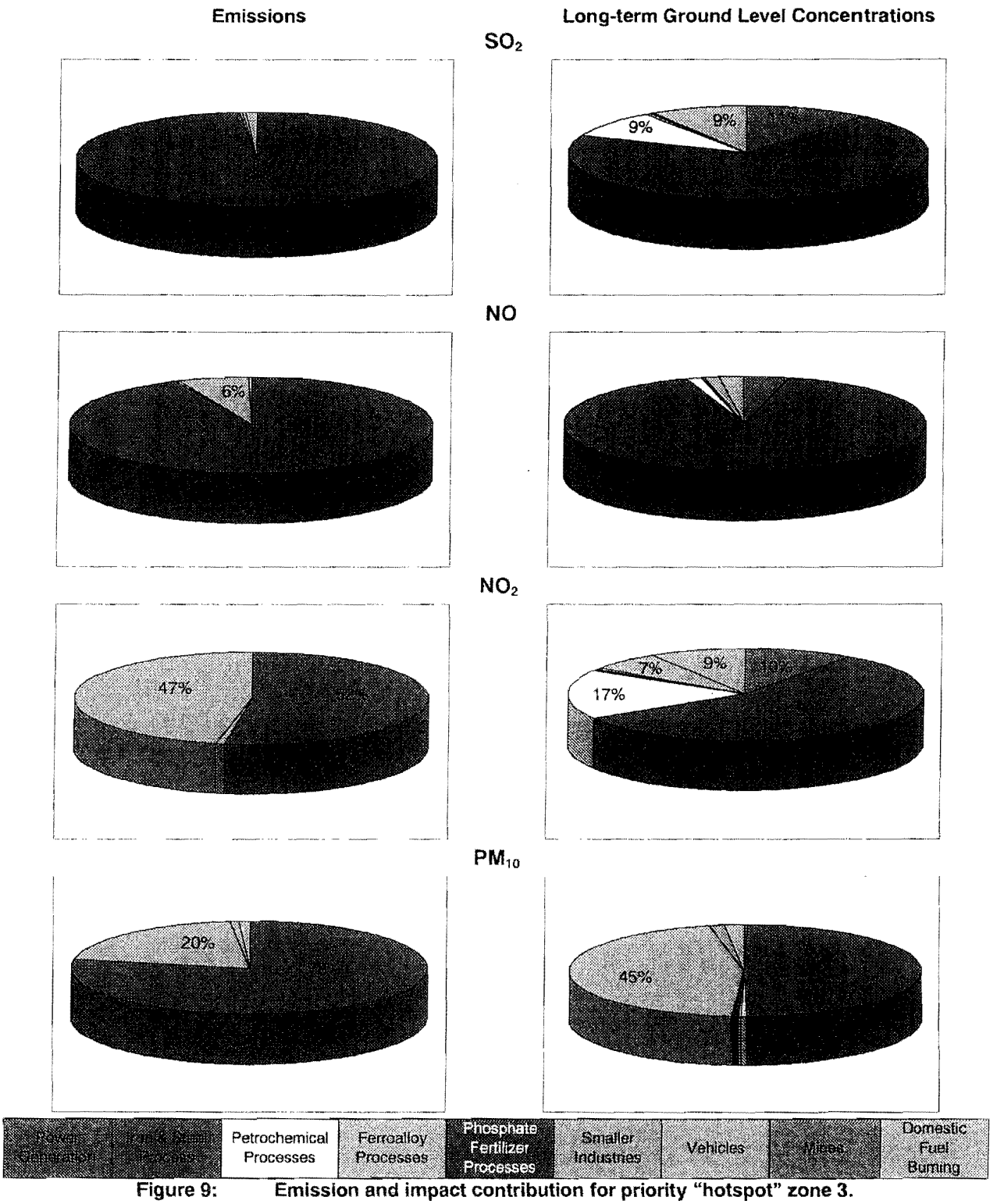

Figure 9: Emission and impact contribution for priority "hotspot" zone 3.

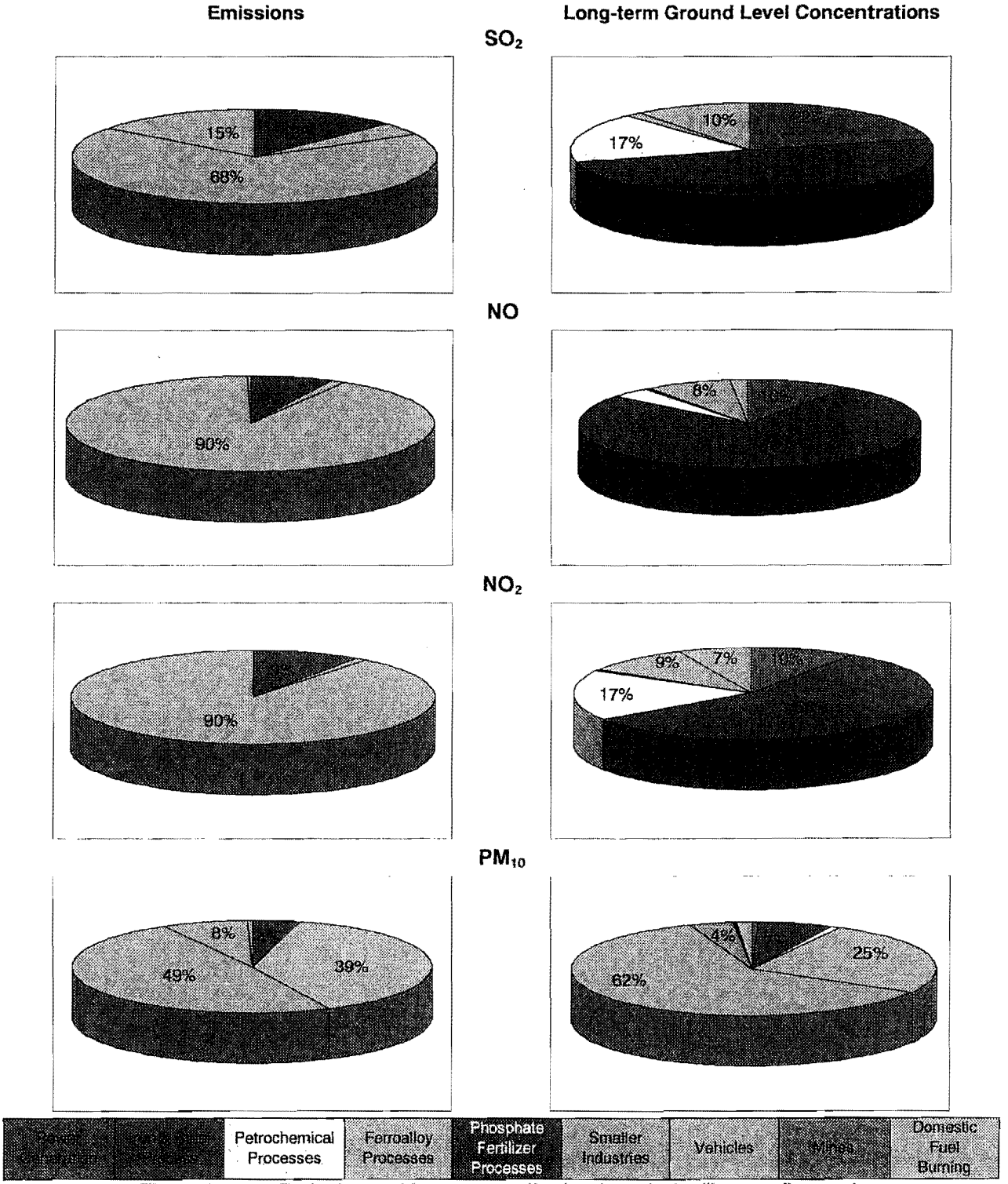

Figure 10: Emission and impact contribution for priority "hotspot" zone 4.

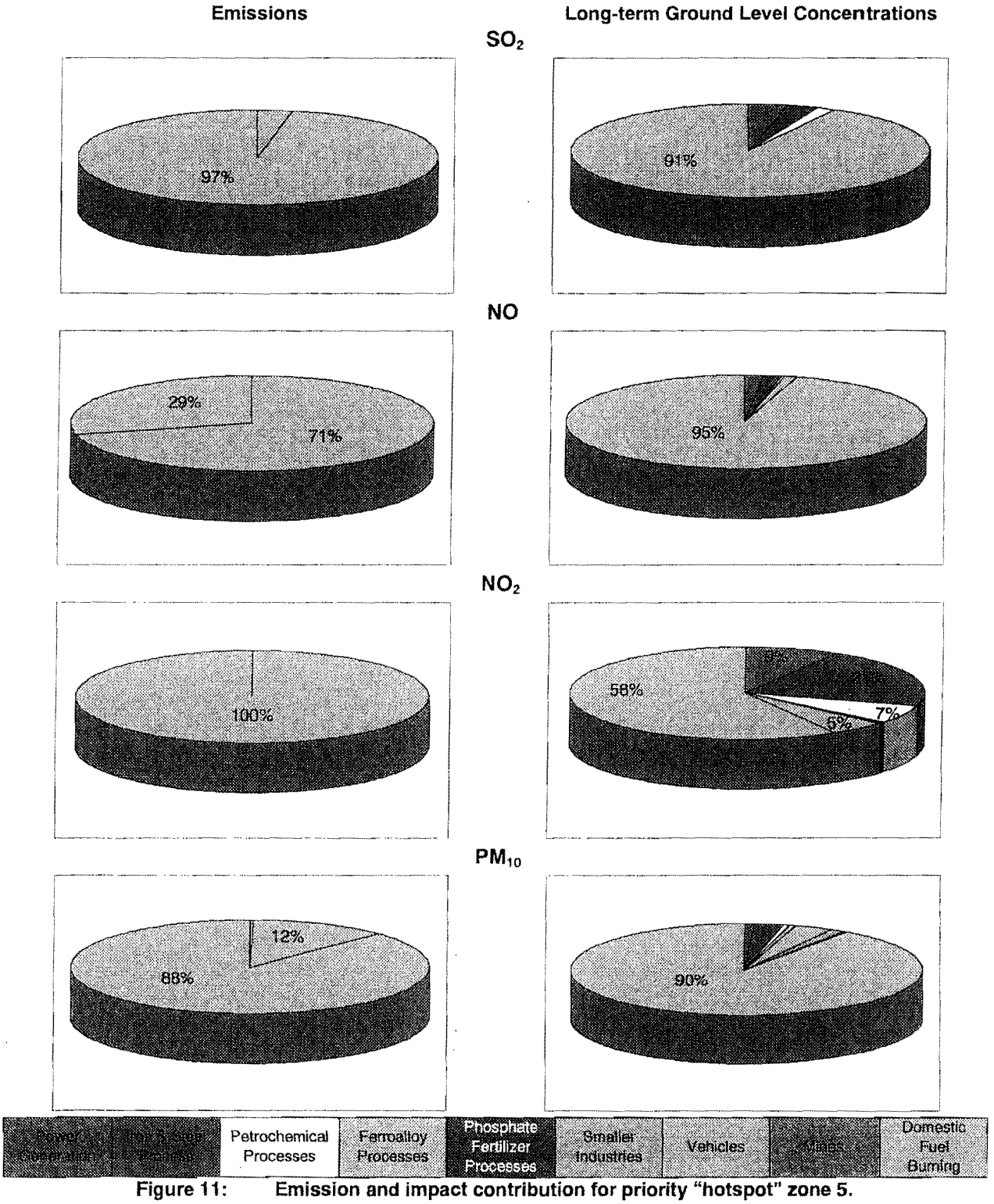

Figure 11: Emission and impact contribution for priority "hotspot" zone 5.

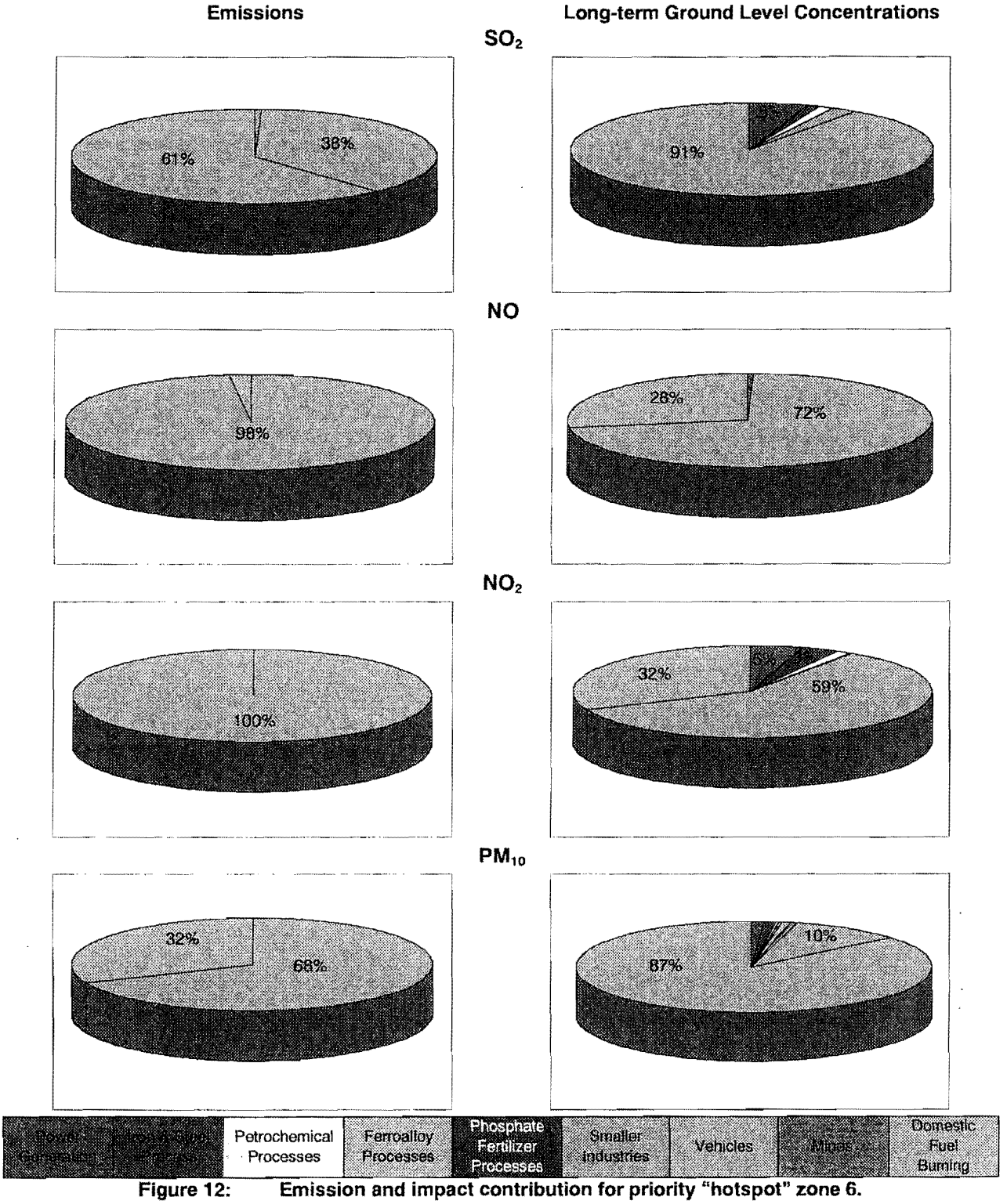

Figure 12: Emission and impact contribution for priority "hotspot" zone 6.

2.6.4 Capacity Assessment

Based on the capacity assessment of the various spheres of government (National, Provincial ad Local), it is clear that there is an intentional drive from National Government (DEAT) to built capacity and implement the various components of the Air Quality Act. At National level, a Chief Directorate has been established for Air Quality Management and Climate Change with a Directorate specifically focusing on Air Quality Management. Subsequently a sub-directorate has also been developed which clearly shows DEAT's commitment to air quality management. DEAT will ultimately be responsible for the implementation and roll-out of the VTAPA AQMP.

On provincial level, Gauteng has a Directorate devoted to Air Quality falling under the Chief Directorate Sustainable use of the Environment with the Free State only having a sub-directorate for Air Quality Management under Environmental Quality.

The City of Johannesburg is probably the most experienced in air quality management with their AQMP already implemented in 2003 and currently undergoing the first review period.

Within the Sedibeng District Municipality air quality are managed by Environmental Health Services with most of the air quality responsibilities being that of the Environmental Health Practitioners. Similarly, Environmental Health Practitioners are responsible for all air quality related functions at Local Municipal level. This include amongst others, compiling and updating an emissions inventory on all small boiler operations within the municipality. With the exception of Emfuleni Local Municipality no complete inventory exists. Other functions include diesel vehicle testing and air quality related complaints attendance.

The shortfalls have mainly been identified as the lack of interaction between the various spheres of government that would have to be carefully structure to prevent duplication of work or the neglect of functions. A communication and reporting framework will have to form part of the AQMP (DEAT, 2007).

3 METHODOLOGY FOR THE DEVELOPMENT OF AN AIR QUALITY MANAGEMENT PLAN

3.1 Best Practice in Air Quality Management

It is well established that human health and well-being are affected by urban air pollution, which has both acute and chronic impacts. In addition, the degradation of materials by air pollution has been observed over centuries with specific reference to impacts on stone and iron from acidifying sulphur compounds. The impact of air pollution on the natural environment is also an important factor that should be considered (Fenger *et al.* 1998). The main aim for air quality management planning is therefore to avoid and reduce any adverse effects on public health and the environment.

Since air pollution knows no political or geographical boundaries, airshed activities may be focussed on a single community or a number of neighbouring communities facing similar air quality problems. Air quality management planning, also known as "Airshed planning" takes a multi-stakeholder, multi-source approach to coordinating actions within a distinct geographical area or "airshed[2]". The Air Quality Management Plan (or Airshed Plan) provides the blueprint for managing and controlling air pollution by identifying air quality objectives and prioritizing these goals. In British Columbia for example, the major sources of air pollution use to be large industrial operations that was regulated through permits. However, due to the reductions in industrial air pollution over the past 20 years, the relative contributions from other sources such as motor vehicles and biomass burning increased (Williams and Bhattacharyya, 2004). Thus, the requirements and objectives for air quality management in British Columbia have changed.

According the Guide to Airshed Planning in British Columbia, the main steps in compiling an Air Quality Management Plan include the following:

- Problem identification: Does current air quality monitoring suggest that there is a problem? What factors or sources are contributing to this problem?
- Plan development: What are the most appropriate air-emission reduction measures to achieve local goals, and what are the relative priorities?
- Implementation and reporting: How and when will the measures be implemented, and by whom? How often will progress be reviewed and reported upon? (Williams and Bhattacharyya, 2004).

3.1.1 Problem Identification

The objective of problem identification is to determine if there is an air quality problem and if so, what is causing it. This takes into account the current ambient air quality concentrations, the dispersion potential of the site and the main contributing sources of emissions. Monitoring is a major problem identification tool but modelling may be required to pull all the strings together and understand the spatial extend of the problem.

The Baseline Assessment conducted as part of the Vaal Triangle Airshed Priority Area Air Quality Management Plan (VTAPA AQMP) development provided the foundation for the problem identification.

[2] An Airshed is generally described as an area where the movement of air (and therefore air pollutants) can be hindered by local geographical features and by weather conditions (Williams and Bhattacharyya, 2004).

3.1.2 Plan Development

The development of an Air Quality Management Plan requires several steps as is reflected in Figure 13.

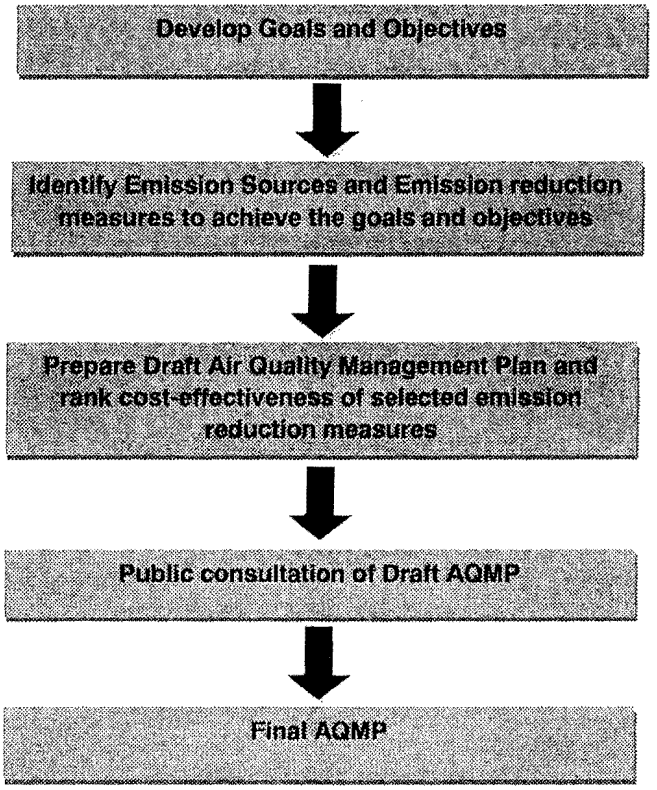

Figure 13: Air Quality Management Plan Development Process

The AQMP goals and objectives should consider various criteria reflecting the actual status of the air quality in the Airshed but also the concerns of the community regarding the ambient air quality and the potential for improving it. Socio-economic considerations are also an important component of an AQMP. Even though the goals and objectives of an AQMP will differ between airsheds, the main criteria to be considered are as follows:

- Air emissions must be considered in an integrated, multi-pollutant approach.
- Emission reductions should be optimized to ensure that it is made in a fair, just and cost-effective manner.
- The reduction of emissions may have significant co-benefits (i.e. reduction of other air emissions in the airshed such as hazardous air pollutants and greenhouse gases) that should be optimized.
- Local actions to improve air quality may have regional and even global impacts.
- Development of an AQMP should be based on best available science.

The air quality goals and objectives that are selected directly influences the choice of emission reduction measures which forms the benchmark for measuring improvements (Williams and Bhattacharyya, 2004).

3.1.3 Implementation and Reporting

The implementation of an AQMP is a multi-stakeholder task and therefore a coordinated, cooperative strategy involving all spheres of government and stakeholders is needed to successfully implement an AQMP. It is also prudent that a review schedule form part of the implementation strategy.

It is necessary to develop criteria for a prioritised and phased-in implementation. The main criteria for intervention descriptions should be the status quo of the air quality within the Airshed, and the overall effectiveness to achieve the objectives and goals. Generally, the prioritisation of interventions is based on the ease of implementation and the cost-effectiveness of it in relation to the benefits gained. The interventions selected for the short- to medium term might also not necessarily achieve the overall emission reduction targets. A realistic implementation schedule and milestones to track progress are therefore a practical and necessary step. Once started, the implementation of the AQMP becomes a continuous intergovernmental effort involving all stakeholders (Williams and Bhattacharyya, 2004).

3.2 Framework for an Air Quality Management Plan

The development of the Vaal Triangle Airshed Priority Area (VTAPA) Air Quality Management Plan (AQMP) on behalf of the Department of Environmental Affairs and Tourism (DEAT) followed the international methodological approach of Logical Framework Analysis (NORAD, 1999). Logical Framework Analysis (LFA) is a methodology for developing programmes or projects through a phased approach:

- Situation Analysis
    - Stakeholder Analysis
    - Problem Analysis
    - Objective Analysis
- Strategy Analysis
- Project Planning Matrix
    - Matrix
    - Assumptions
    - Objective Indications
    - Verification
- Implementation

This approach provides a set of designing tools that can be used for planning, designing, implementing and evaluating projects. The purpose of LFA is to undertake participatory, objective-orientated planning over the duration of the project to build stakeholder team commitment and capacity through workshops. This approach addressed all three the main steps in the development of an AQMP as outlined in Section 3.1.

3.2.1 Situation Analysis

The first step in the approach involves the analysis of the existing situation and the development of objectives. The task of a situation analysis is to identify the actual state of affairs with respect to an issue to be analysed. It is focused by problems and an attempt to understand the system, which determines the existence of the problems. A Situation Analysis comprises of both a Problem Analysis and Objectives Analysis. In the analysis of the problem, a 'Problem Tree' is developed through an analysis of cause and effect relationships. An Objectives Analysis is a procedure for systematically identifying, categorising and specifying objectives. The Problem Tree is transformed into an Objectives Tree by restating the problems as objectives.

3.2.2 Strategy Analysis

A Strategy Analysis is a systematic way of searching for and deciding on problem solutions. It follows the Problem and Objectives analysis and is a prerequisite to designing action strategies. This involves the selection of a strategy to achieve the desired results and comprises the clusters of objectives to be included in the project. Strategy Analysis also looks at the feasibility of different interventions.

3.2.3 Project Planning Matrix

Project Planning Matrix is developed from the Strategy Analysis. The goals, purpose, outputs/results and inputs/activities are transposed from the Strategy Tree to the columns and rows in the Matrix (Table 25).

The Project Planning Matrix provides a summary of:

- Why a project is carried out
- What the project is expected to achieve
- How the project is going to achieve its outputs/results
- Which external factors are crucial for the success of the project (risks)
- How we can assess the success (indicators)
- Where we will find the data required to assess the success (means of verification)

Table 25: Example of a Project Planning Matrix.

Narrative Summary	Measurable Indicators	Means of Verification	Assumptions
Goals/Objective	Measures of goal achievement	Various source of information; methods used	Goals-purpose linkages
Project Purpose	End-of-project status	Various sources of information; methods used	Output-purpose linkages
Outputs/Results	Magnitudes of outputs, planned dates of completion	Various sources of information; methods used	Input-output linkages
Inputs/Activities	Types/levels of resources; starting date	Project data; other sources of information	Initial assumptions regarding the causality of the programme

The main elements of a Project Planning Matrix include:

- Narrative Summary
  - *Goals/Objectives* - the development of a goal describes the developmental benefits which the respective target groups can gain from a project
  - *Project Purpose* – describes the change in behaviour, structures or capacity of the target groups which directly result from the utilisation of the deliverable outputs or results the project will yield
  - *Outputs/Results* – describes the goods and services, the direct deliverables which are contributed from the side of a project

- *Inputs/activities* – measures/tasks to be carried out by the project in order to achieve the outputs/results

- Measurable Indicators
  - For each cell of the narrative summary, indicators need to be developed which should be measurable, feasible, relevant and accurate, sensitive and timely.

- Means of Verification
  - Once indicators have been developed, the source of information and the means of collection should be established for each indicator. A means of verification should test whether or not an indicator can be realistically measured at the expense of a reasonable amount of time, finance and effort.

- Assumptions
  - The aim of specifying assumptions is to (a) assess the potential risks to the project concept right from the initial stages of the project, (b) support the monitoring of risks during the implementation of the project and (c) provide a firm basis for the necessary adjustments within the project whenever it is required.

3.2.4 Implementation

The operational phase of a project commences when implementing activities begin in order to achieve the expected outputs/results. Implementation should have a detailed plan of operations i.e. the detailed plan for the implementation of the project.

4 PROBLEM IDENTIFICATION AND OBJECTIVES ANALYSIS

Using the Logical Framework Approach, the main problems and critical gaps associated with air quality and the management thereof were identified through an initial characterisation of the existing situation in the Vaal Triangle Airshed Priority Area. The Baseline Assessment determined the existing air quality status in the region, identified problem sources and areas through dispersion modelling and assessed capacity for air quality management within all spheres of government. Subsequently, information obtained from this initial assessment was used to identify the major problems in the region and develop corresponding objectives to correct these problems.

A problem tree is developed for an identified problem around which cause and effect relationships are established. These problems are then restated into achievable objectives that will result in the desired outcome for the Vaal Triangle Airshed Priority Area, which is an acceptable air quality in the region. Using this methodology, eleven problem complexes were identified around which problem and associated objectives trees were developed (Figure 14 - Figure 35). A problem complex is a set of problems with similar cause and effect relationships that are not specifically related to a specific location. These have been divided into 'emission' problem complexes and 'non-emission' problem complexes. Emission problem complexes have been identified as the major contributing sources in the VTAPA and these include (listed alphabetically and not according to significance):

- Biomass Burning
- Domestic Fuel Burning
- Iron and Steel/Ferroalloys (combined)
- Mining
- Petrochemical
- Power Generation
- Small Industries
- Transportation
- Waste Burning

Non-emission problem complexes, which affect air quality management and control in the region, have been identified as:

- Government Capacity for Air Quality Management
- Information Management

4.1 Biomass Burning

Biomass burning was not quantified as part of the Baseline Assessment for the VTAPA due to the lack of site-specific information and difficulty associated with simulating impacts from such incidences. Even so, crop-residue burning and general wild fires (veld fires) represent significant sources of combustion-related emissions associated with agricultural areas. The significance of seasonal impacts due to biomass burning is well known and recorded (Piketh *et al.*, 1996).

4.1.1 Problem Analysis

Problems associated with biomass burning include the negligent or accidental burning of land and current perception of burning as well as inadequate management strategies to control burning i.e. during periods of poor dispersion. As a result, the impacts of biomass burning on human health, atmospheric chemistry and secondary particulate formation could not accurately be determined.

The primary problem associated with biomass burning is the high seasonal and localised emissions from biomass burning as shown in Figure 14. The cause of such high emissions is the incomplete combustion process, and the main pollutants of concern associated with it include carbon monoxide, methane and nitrogen dioxide being emitted during the process.

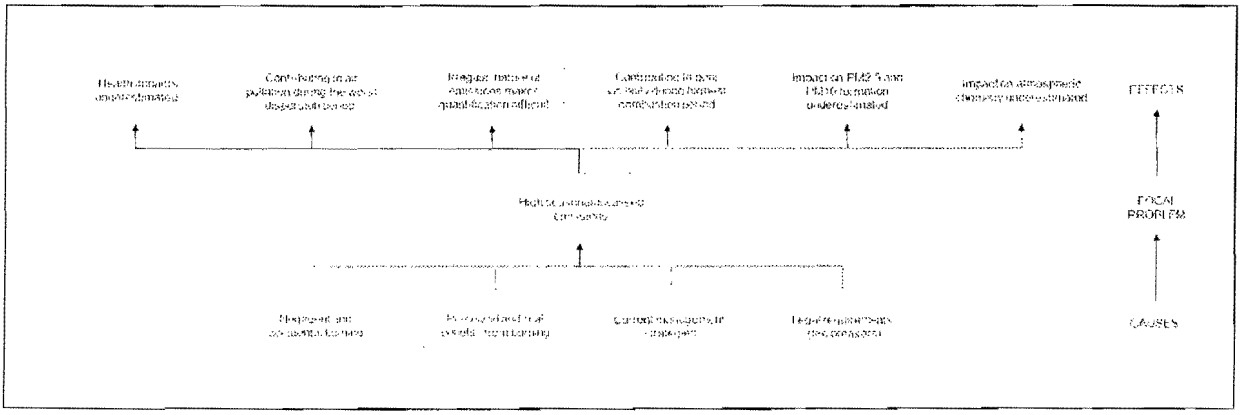

Figure 14: Problem Tree for Biomass Burning.

4.1.1.1 Problem Cause

The main causes of such high localised impacts have been identified as:

- Accidental burning;
- Perceived and real benefits from burning;
- Current management strategies; and,
- Legal requirements (fire breaks).

Accidental burning includes fires caused by smoking materials, lightning strikes, faulty electrical systems (including product defects, poor installations and electrical wiring), spontaneous combustion (specifically coal combustion); and overall negligence (http://www.interfire.org/res_file/m_fse_oa.asp).

It is believed that agricultural burning stimulates new grass growth and improve wildlife habitat, boost pasture productivity and enhance native plant communities. Thus, this is one of the *perceived and real benefits* resulting from biomass burning. Controlled or prescribed burning is a recognised practice to improve growth of natural habitats and differs from wild fires and uncontrolled burning.

Current management strategies - local authorities seldom have strategies on managing controlled and regulated fires. No such strategies were found to exist in the Local Municipalities of Metsimaholo, Emfuleni, Midvaal or the

City of Johannesburg Metropolitan Municipality. A lack of strategy would result in a greater probability of accidental veld fires since burnt areas cannot be set alight.

Controlled or prescribed burning is often a *legal requirement (fire breaks)* as part of municipal by-laws. This is primarily to prevent uncontrolled burning and wild fires to occur. By conducting controlled burning of open exposed areas, the risk of fires are minimised resulting in the protection of private property and minimising loss of human lives. Unfortunately, the legal requirements are not always accompanied by implementation plans or management strategies for the controlled burning of open areas as indicated above.

4.1.1.2 Resulting Effects

The effects from high seasonal and localised emissions were identified as the following:

- Health impacts underestimated;
- Contributing to air pollution during worst dispersion periods;
- Irregular nature of emissions makes quantification difficult;
- Contributing to poor visibility during highest combustion periods;
- Impact on $PM_{2.5}$ and PM_{10} formation underestimated; and,
- Impact on atmospheric chemistry underestimated.

The main concern from air pollution in general is the implications for human health. About 40% of the nitrogen in biomass is emitted as nitrogen, 10% remains in the ashes and it is assumed that 20% of the nitrogen is emitted as higher molecular weight nitrogen compounds. Since it is difficult to estimate what percentage of ground level concentrations are contributed by biomass burning the significance of these events are not well understood and it is expected that it is underestimated.

The contribution during worst dispersion periods includes night-time conditions or when it is overcast. The vertical component of dispersion is a function of the extent of thermal turbulence and the depth of the surface mixing layer. During the daytime, the atmospheric boundary layer is characterised by thermal turbulence due to the heating of the earth's surface and the extension of the *mixing layer* to the lowest elevated inversion. Radiative flux divergence during the night usually results in the establishment of ground based inversions and the erosion of the mixing layer. During the night, a stable layer, with limited vertical mixing, exists resulting in poor dispersion potential of low-level release sources such as biomass burning.

The visibility of smoke plumes from vegetation fires is due to their aerosol content. The reduction in visibility due to biomass burning is significant when such incidents occur near roads. This can result in accidents, which could be fatal.

PM_{10} is known as inhalable particulates whereas $PM_{2.5}$ is known as respirable particulates. Both PM_{10} and $PM_{2.5}$ concentrations are associated with potential health impacts. The concern with biomass burning is high potential of secondary anthropogenic $PM_{2.5}$ formation due to incomplete combustion of organic matter. It is expected that the amount of PM_{10} and $PM_{2.5}$ resulting from biomass burning is underestimated and hence the potential health risk associated with it. This also directly relate to the underestimation of the effect on atmospheric chemistry such as photochemistry.

4.1.2 Objectives

Given the understanding that veld fires cannot be eliminated (fires due to lightning etc.), the essential objective is to minimise the impacts from biomass burning on the surrounding environment and human health. In order to minimise the impact of emissions from biomass burning, it is necessary to:

- educate the public around the causes and effects of uncontrolled veld fires;
- promote the benefits of controlled (prescribed) burning; and,
- incorporate management strategies that take into account the prevailing meteorological conditions.

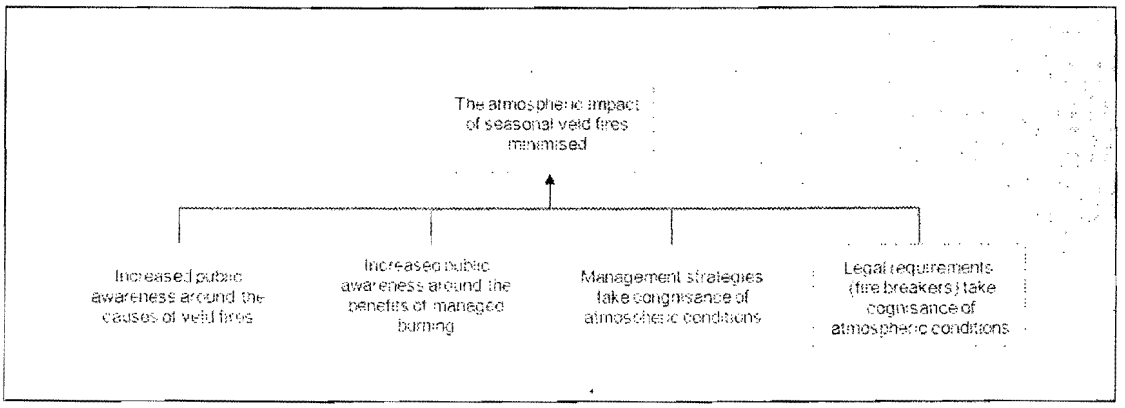

Figure 15: Objectives Tree for Biomass Burning.

4.2 Domestic Fuel Burning

Domestic coal combustion within informal settlements has been identified during various studies to be potentially one of the greatest sources of airborne particulates and gaseous emissions within urban areas. This was confirmed by the Baseline Assessment for specifically low income areas within the Vaal Triangle Airshed Priority Area. Traditionally, use is made of wood, dung and bagasse but in the urban areas increasingly use is made of paraffin and LPG. In Gauteng specifically high coal consumption figures for the province is evident and is mainly due to the relatively inexpensive nature of coal and the fact that it is easily accessible.

4.2.1 Problem Analysis

Given low level of release of domestic fuel burning appliances within the breathing space of people and sometimes even in enclosed areas, the impacts are significant resulting in poor health (Figure 16).

4.2.1.1 Problem Cause

It is recognised that poverty is a major contributing factor to the use of domestic fuels in households and that a cyclical relationship exists with this particular 'problem complex'. Well vented and fuel efficient stoves are expensive and not widely available. The continuous use of coal as an energy source is also due to the rapid urbanisation and the growth of informal settlements that has exacerbated backlogs in the distribution of basic services such as electricity and waste removal. Due to poverty, people cannot afford better technology

appliances for cooking, space heating and lighting and the result is badly vented and inefficient stoves. Thus, reliance is made on traditional fire making practices resulting in excessive emissions. In parallel, the use of electricity is not just expensive, it requires specific appliances in order to cook and provide a source of light, and heating during winter months. In addition, various electrified households continue to use coal due particularly to its cost effectiveness for space heating purposes and its multi-functional nature (supports cooking, heating and lighting functions).

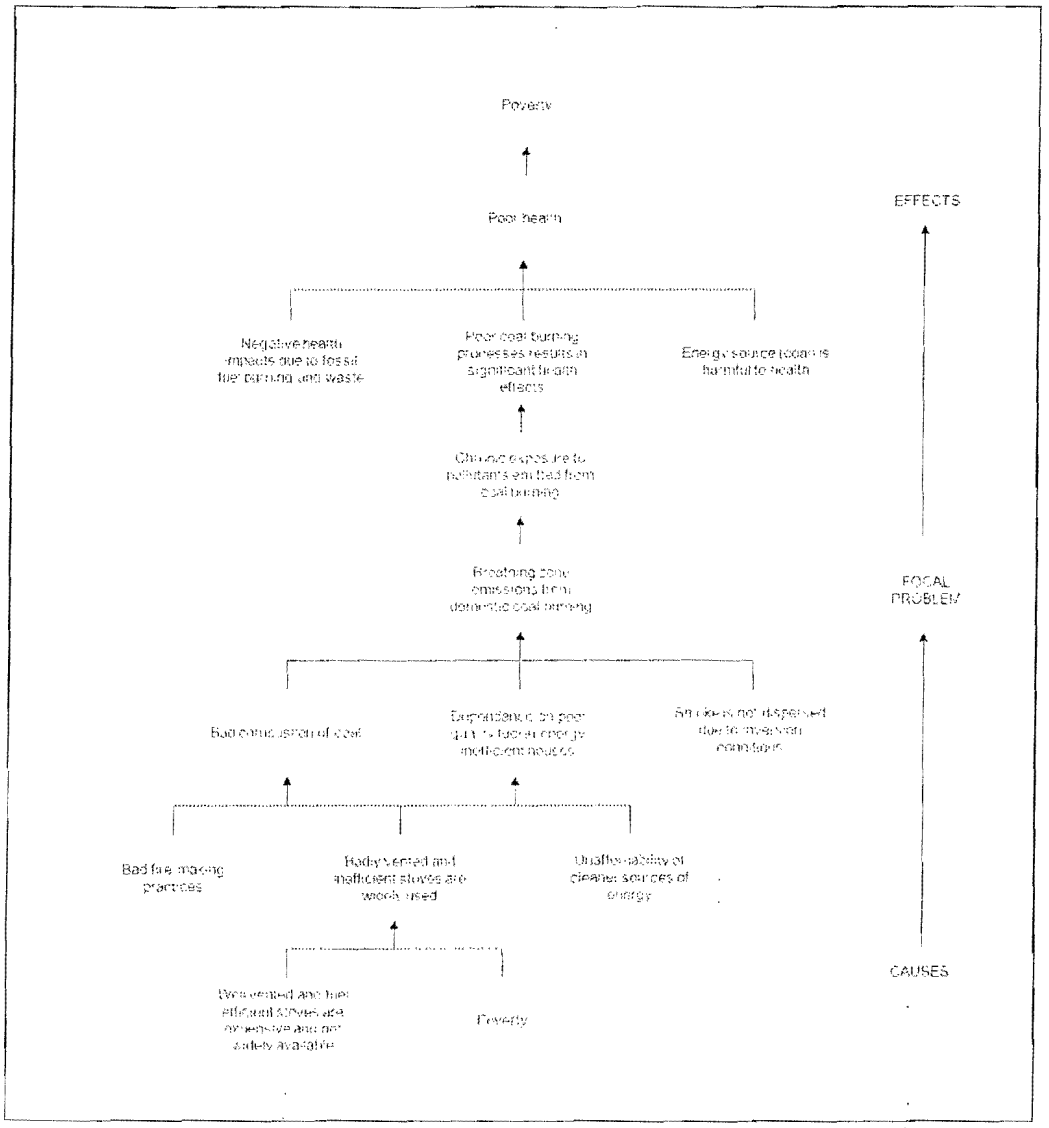

Figure 16: Problem Tree for Domestic Fuel Burning.

An additional cause of high levels of emissions resulting from domestic fuel burning is the poor quality of coal used. Again, this is widely available and affordable. Poor quality coal is typically high is ash and sulphur content which directly relates to the amount of particulates and sulphur dioxide emitted to air. Similar to biomass burning, the concern pertaining to particulates is the formation of respirable ($PM_{2.5}$) emissions due to incomplete combustion. The latter again is a result of the poor quality coal, fire making practices and inefficient stoves used. In addition, the houses in low-income areas are usually poorly insulated demanding more frequent heating. Together with the poor combustion of the coal, a typical household ends up using more coal that result in higher levels of emissions in the breathing zone. As a result, residents in these informal areas are exposed to high levels of pollution, which have the potential for significant human health effects.

4.2.1.2 Resulting Effects

The result from domestic fuel burning is the chronic exposure to pollutants emitted from coal combustion. Coal burning emits a large amount of gaseous and particulate pollutants including sulphur dioxide, heavy metals, total and respirable particulates including heavy metals and inorganic ash, carbon monoxide, polycyclic aromatic hydrocarbons, and benzo(a)pyrene. Polyaromatic hydrocarbons are recognised as carcinogens. Pollutants arising due to the combustion of wood include respirable particulates, nitrogen dioxide, carbon monoxide, polycyclic aromatic hydrocarbons, particulate benzo(a)pyrene and formaldehyde.

According to the NEDLAC 'Dirty Fuels' project findings, domestic fuel burning was estimated to result in the greatest non-carcinogenic health risk across all conurbations[3]. In the Vaal Triangle, fuel combustion related emissions were estimated to account for ~9,400 cases of respiratory hospitalisations. Approximately 77% of such cases were predicted to be due to domestic fuel burning; 57% due to coal and 20% due to wood burning. Furthermore, domestic fuel burning was estimated to be responsible for 90% of the excess leukaemia cases predicted due to exposures to fuel burning emissions (Scorgie *et al.*, 2004).

An increase in poor health results in an increase in inability to work which in turn results in an increase in poverty. Thus, the ultimate effect of domestic fuel emissions on society is an increase in poverty, which is also the main cause of using in-expensive fuels in the first place.

4.2.2 Objectives

To reduce the current air pollution concentrations to acceptable levels in domestic fuel burning areas, it is necessary to make available alternative energy sources that are affordable, as well as promote the use of more energy efficient stoves.

Through the improved combustion of coal as well as the reduced dependence on poor quality fuel, emissions from domestic coal burning can be effectively minimised.

[3] The conurbations in the NEDLAC study included: the CTMM, the COJ, EMM, the Vaal Triangle, the City of Cape Town, eThekwini and the Mpumalanga Highveld.

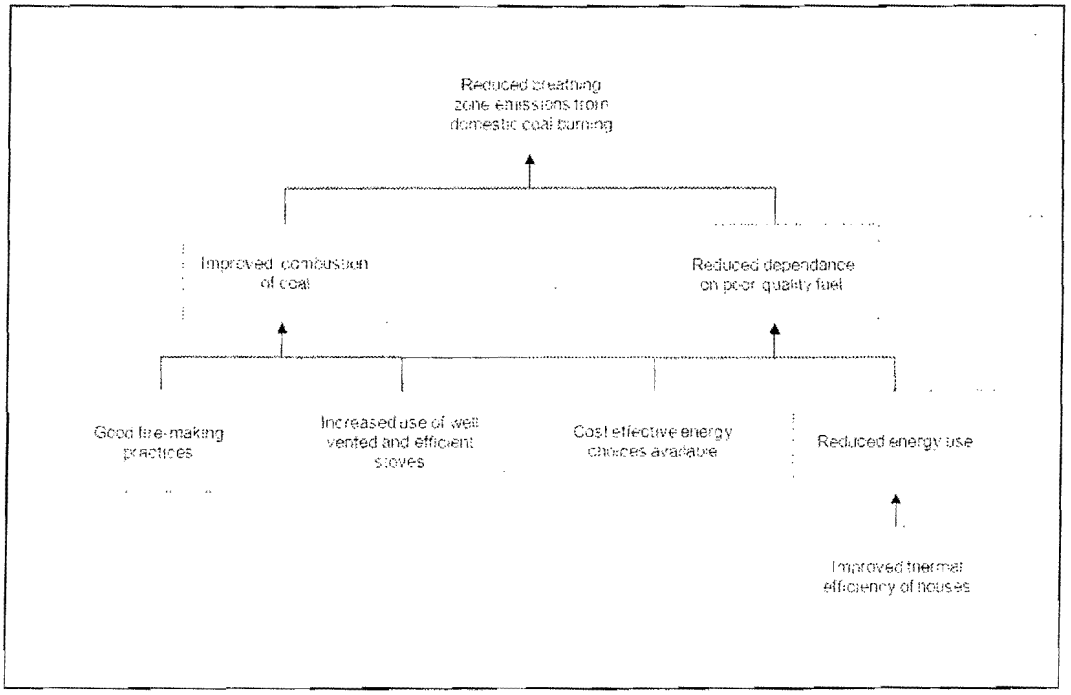

Figure 17: Objectives Tree for Domestic Fuel Burning.

4.3 Iron and Steel /Ferroalloys Industry

Emissions from the Iron and Steel and Ferroalloy industries, in particular, dust emissions, have been identified to be an important contributor to the overall ambient air quality situation in the Vaal Triangle Airshed Priority Area.

ArcelorMittal South Africa (Vanderbijlpark steel and Vereeniging Works) and Davsteel (Cape Gate) are the main Iron and Steel producing facilities within the VTAPA. Samancor Meyerton (Metalloys) is the only Ferroalloy industry producing Ferro-Manganese.

4.3.1 Problem Analysis

Large volumes of atmospheric emissions are the main problem associated with Iron and Steel-, and Ferroalloy industries. Figure 18 provide the problem tree for this problem complex.

4.3.1.1 Problem Cause

Activities that generate significant quantities of dust emissions include vehicle entrainment on unpaved roads, wind-blown dust from the stockpiles and material handling operations. Old technology and outdated pant designs are one of the main causes of high emissions and specifically fugitive releases.

Fugitive dust emissions from vehicle entrainment are primarily due to poor transport practices. This includes unpaved roads on-site and poor house-keeping on paved roads resulting in excessive dust accumulation on the

road surfaces. The unpaved roads surfaces and dusty paved surfaces result in the entrainment of dust as soon as vehicles pass over it. Dust from open trucks falling onto the road surfaces also adds to the problem.

In addition to vehicle entrainment from road surfaces, windblown dust from large, dry surface areas is also a matter of concern. Significant emissions arise due to the mechanical disturbance of granular material from open areas and storage piles. Parameters which have the potential to impact on the rate of emission of fugitive dust include the extent of surface compaction, moisture content, ground cover, the shape of the storage pile, particle size distribution, wind speed and precipitation.

Materials handling primarily include the movement, loading and unloading of material. Fine particulates are most readily disaggregated and released to the atmosphere during the material transfer process, because of exposure to strong winds.

One of the main areas of concern at plants relying on old technology and outdated plant design is the inefficiency of the processes. For example, at old technology coke ovens the doors still need to be manually sealed usually resulting in lid and door leaks where air can seep in. This result in poor and inefficient coking process, which need to take place in an oxygen deprived environment. Thus, as soon as the coke is pushed out of the ovens the side areas where the coal was not converted to coke result in high volumes of smoke. Another example of old technology is the capturing of secondary emissions usually from the furnace buildings. Old plant designs did not include the extraction of secondary emissions from furnace buildings resulting in the emissions to be released directly to atmosphere through the rooftop vents. The focus of Schedule Processes under APPA on stack (point-source) releases was one of the reasons why this was never included in the plant design. Furthermore, the APPA Registration Certificates were lenient and did not relate the stack releases to the off-site ambient concentrations. It also did not take into account industrial development in areas and the poor land-use planning resulting in residential areas developing on the doorstep of industries. The result is gaseous and particulate emission releases from stacks complying with Registration Certificate conditions but resulting in exceedances of ambient air quality standards and objectives.

Air pollution from flares was also identified as a source of high atmospheric emissions. Flares are used to ensure plant stability and are primarily a result of outdated plant designs.

4.3.1.2 Resulting Effects

The resulting effect from the problems identified is non-compliance of the industrial activities with ambient air quality standards and objectives off-site, and at residential areas surrounding the industrial zones. Thus, the ultimate effect as with all the identified problem complexes is the negative impacts on human health and the environment.

4.3.2 Objectives

The objective for Iron and Steel-, and Ferro-alloy processes are to comply with both national emission limits and ambient air quality standards. Figure 18 provides the schematic representation of the objectives tree that was derived from the problem tree in Figure 19.

This will require the implementation of Best Available Techniques (BAT) at all the outdated processes on-site. By doing this the efficiency of the process will increase, resulting in less emissions released to atmosphere. In addition, by implementing BAT, most of the emissions will be captured before emitted to atmosphere. Furthermore, the Atmospheric Emissions Licences (AELs) as stipulated under AQA will include all sources of emissions from a specific industrial site, including both point and non-point sources. Minimum emission limits

will be set nationally for all listed activities but the AELs will have site specific emission limits based on the cumulative off-site concentrations resulting from an industry. Thus, the permit will be based on the receiving environment as the focus point. As part of BAT, industries will be required to switch to cleaner alternative fuels, and to optimise processes in order to utilise certain off-gasses as energy sources.

Since the AELs will include all sources of emissions at a site, fugitive releases from vehicle entrainment, materials handling and wind-blown dust will also be addressed. Even though no emission limits can be set for fugitive releases, the AEL can stipulate mitigation measures and procedures for fugitive sources with a specific control efficiency that must be achieved. Thus might include stipulations on the amount of water that must be sprayed on an unpaved roads surface in a given timeframe with monitoring procedures attached to it.

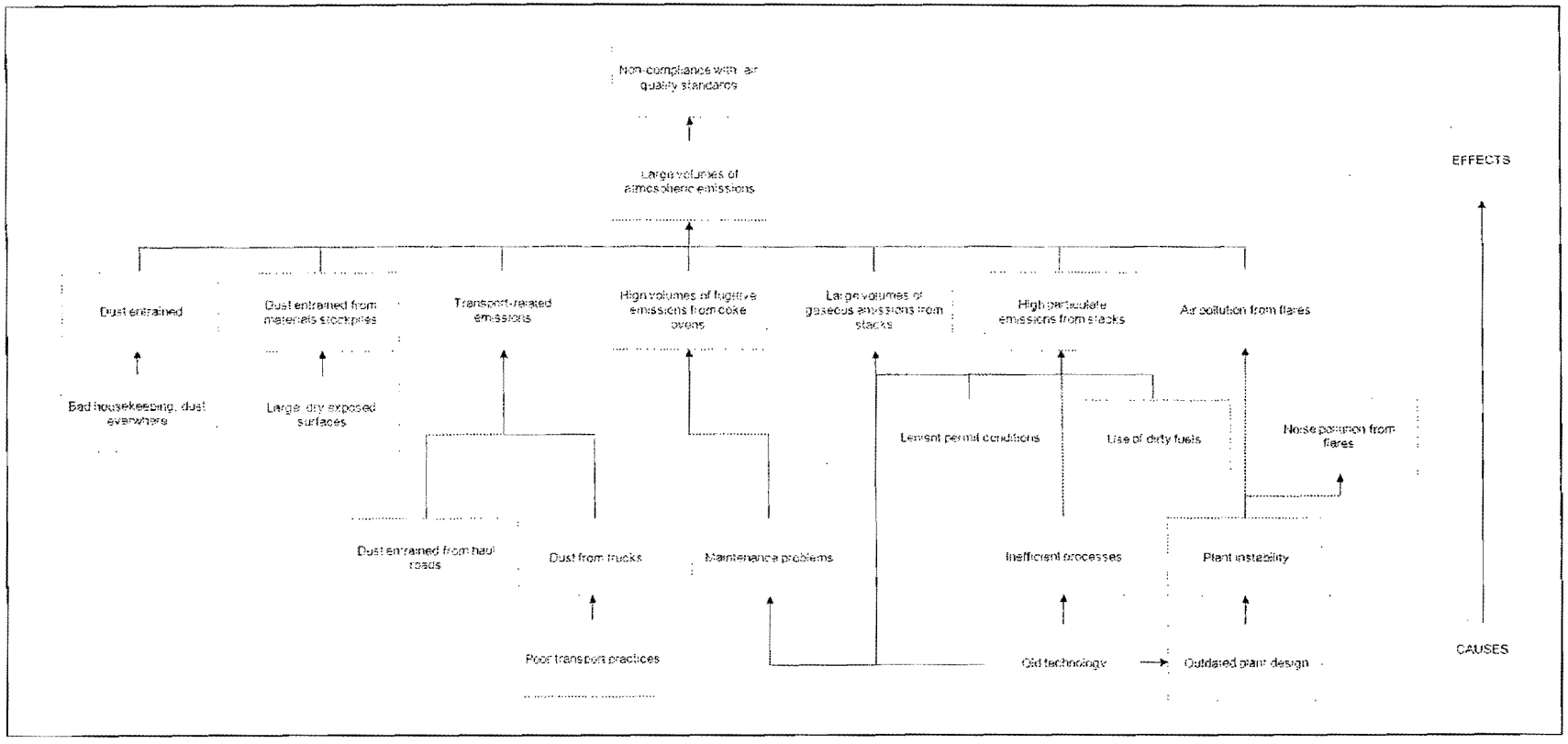

Figure 18: Problem Tree for the Iron and Steel/Ferroalloys Industry.

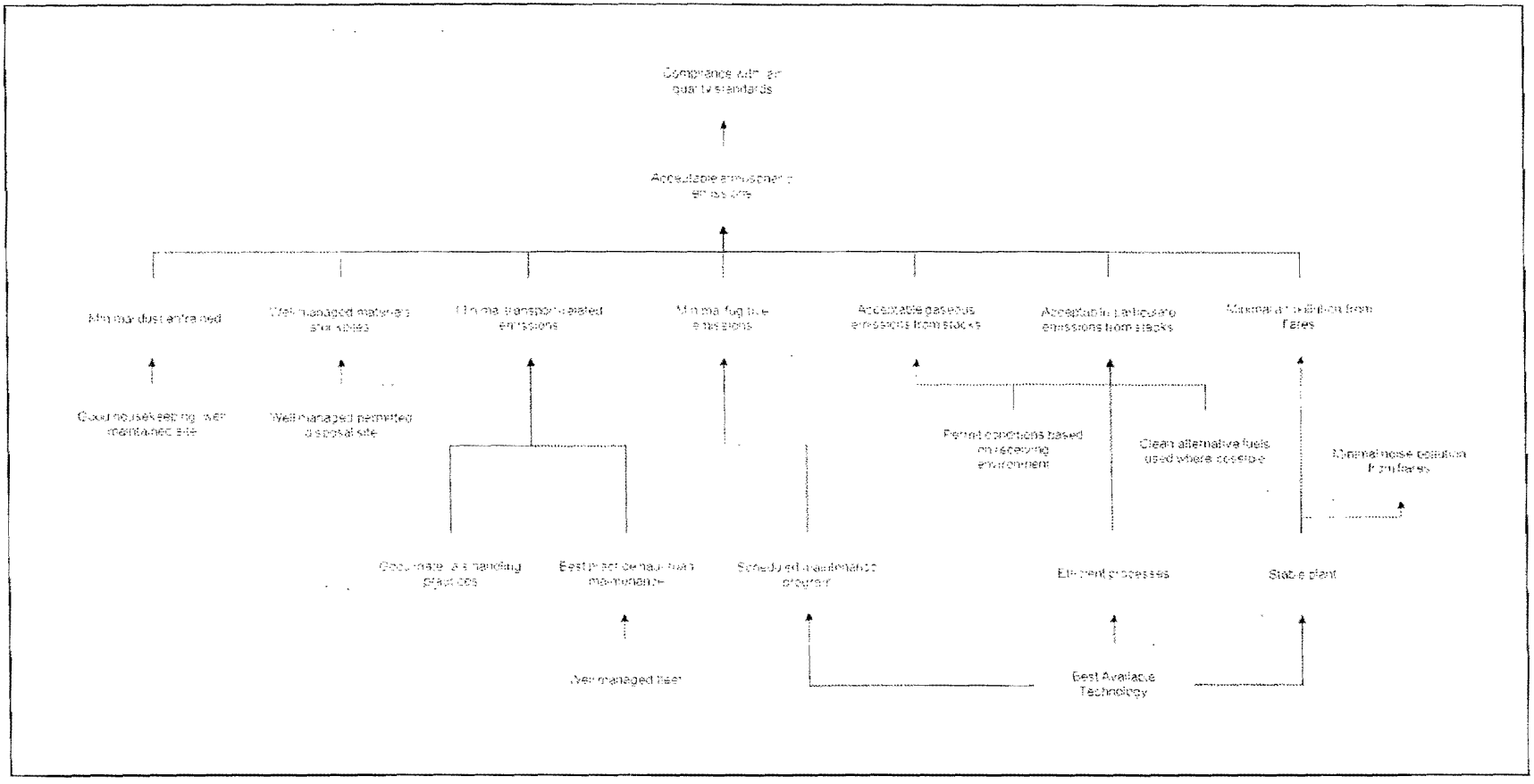

Figure 19: Objectives tree for the Iron and Steel/Ferroalloys Industry.

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4.4 Mining Industry

The mining industry is recognised as an important contributor to the ambient air quality in the region. Elevated emissions occur as a result of operational activities.

There are three mines operational in the VTAPA namely New Vaal Colliery located near Three Rivers (Vereeniging), Sigma Colliery near Sasolburg and Glen Douglas Dolomite Quarry in Meyerton.

4.4.1 Problem Analysis

The problem tree is provided in Figure 20 with the main problem from mining operations identified as the large volumes of pollution generated typically in the form of fugitive releases.

4.4.1.1 Problem Cause

The main problem of opencast mining operations, as is the case of all three the mines located in the Vaal Triangle Priority Area, is the generation of excessive dust emissions. Gaseous emissions are also a problem but to a lesser extent.

Typical operations associated with surface mining include the pre-operational phase where the area is cleared by removal of vegetation, topsoil and overburden. The second phase is the operational phase usually including the movement of ore bearing rock or coal, and exposure of erodible surfaces prone to wind erosion. The final phase entails reclamation where the mined area is restored to its original status.

The initial operation entails the removal of topsoil and subsoil with large scrapers. The topsoil and subsoil is stored in storage piles, which are later used for reclamation purposes. Coal seems (or ore measuring rock) and overburden are drilled and blasted. This is then removed by a shovel and truck operation and placed on a waste dump or overburden pile. A dragline or shovel loads the broken ore or coal into haul trucks, and it is taken out of the pit along graded haul roads to the tipple, or truck dump. Run of mine (ROM) material sometimes may be dumped onto a temporary storage pile and later re-handled by a front-end loader or bulldozer. The material is dumped into a hopper that feeds the primary crusher and it can go onto a secondary and tertiary crusher. The piles, usually worked by bulldozers, are subject to wind erosion.

During mine reclamation, which proceeds continuously throughout the life of the mine, overburden spoils piles are smoothed and contoured by bulldozers. Topsoil is placed on the graded spoils, and the land is prepared for re-vegetation by furrowing, mulching, etc. From the time an area is disturbed until the new vegetation emerges, all disturbed areas are subject to wind erosion.

4.4.1.2 Resulting Effects

Dust-fall impacts are generally confined to the near-field of sources. This is due to the fact that larger particles, which contribute most to dust-fall rates given their mass, are likely to settle out in close proximity to the source (assuming a ground-based source). The larger particulates are the cause of nuisance effects whereas the fine particulates (PM_{10} and $PM_{2.5}$) which remain entrained results in health effects.

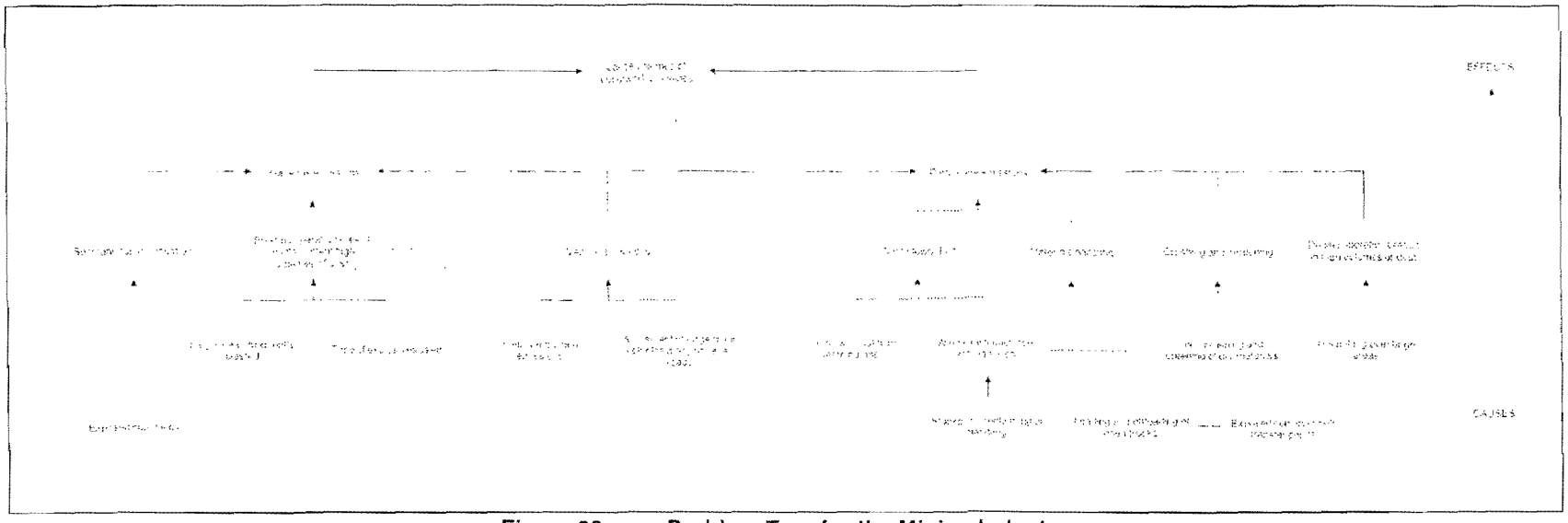

Figure 20: Problem Tree for the Mining Industry.

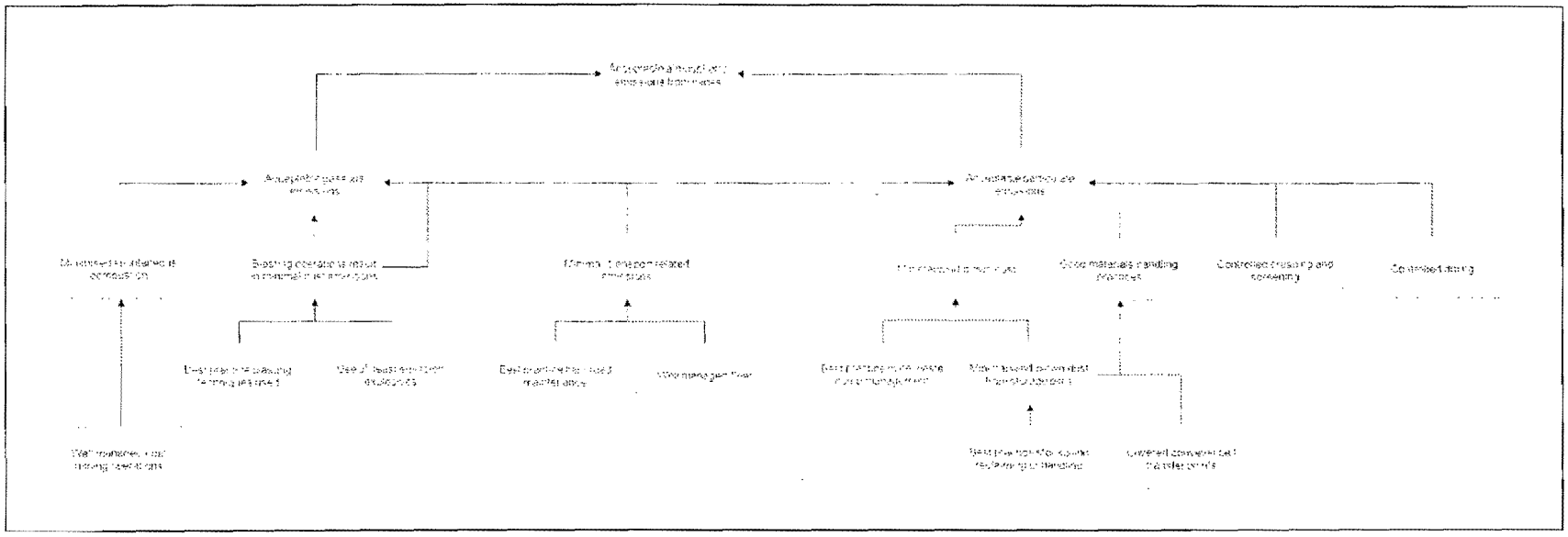

Figure 21: Objectives Tree for the Mining Industry.

4.4.2 Objectives

Objectives to minimise both gaseous and particulate emissions from mining activities include:

- Good materials handling practices (e.g. covered conveyer belts, chemical suppressants at loading and off-loading areas),
- Controlled crushing and screening (enclosed with extraction systems venting through bag-filters),
- Best practice techniques to minimise emissions from waste dumps, stockpiles and dust entrainment along haul roads.

4.5 Petrochemical Industry

Two chemical production facilities are located in the VTAPA namely Sasol Chemical Industries (SCI) and Natref. Both are located in the Sasolburg area. Omnia fertilisers was also grouped with this sector

4.5.1 Problem Analysis

Gaseous and particulate emissions from the petrochemical industry influence the air quality within the Vaal Triangle Airshed Priority Area. Particulate emissions are associated with dust emissions from the waste dumps and stockpiles, as well as the combustion process, which generates both particulate and gaseous emissions.

4.5.1.1 Problem Cause

The current technologies installed to reduce emissions can be outdated and ineffective, and as a result, large quantities of pollutants are released into the airshed.

Significant quantities of dust are generated as a result of wind-blown dust from the stockpiles and waste dumps. Significant emissions arise due to the mechanical disturbance of granular material from open areas and storage piles. Parameters which have the potential to impact on the rate of emission of fugitive dust include the extent of surface compaction, moisture content, ground cover, the shape of the storage pile, particle size distribution, wind speed and precipitation.

Gaseous emissions, in particular SO_2 emissions, have also been identified during the Baseline Assessment to be of concern.

Old technology and outdated plant designs are one of the main causes of high emissions and specifically fugitive releases. This is linked, to some extent, to the outdated legal requirements (i.e. APPA Registration Certificates providing lenient emission limits). One of the main areas of concern at plants relying on old technology and outdated plant design is the inefficiency of the processes. Air pollution from flares was also identified as a source of high atmospheric emissions. Flares are not only used to ensure plant stability but are mainly a safety measure to prevent over pressure and larger damage to the equipment during unplanned upset conditions.

Other concerns surrounding the petrochemical industry include a skills gap as there are limited trained and skilled personnel in the industry as a whole. With the phasing out of APPA and the introduction of sections of AQA, it is unclear to industry what is required in terms of their air quality obligations and allowable operating conditions. Ineffective governance in terms of monitoring practices, reporting practices, enforcement and legislation are also contributing factors to the regulation of emissions from this source.

4.5.1.2 Resulting Effects

The resulting effect from the problems identified is non-compliance of the petrochemical industry with the ambient air quality targets due to particulate and gaseous emissions from this source. The potential for environmental and human health effects is greatest in the neighbouring residential areas, in particular Sasolburg and Zamdela.

4.5.2 Objectives

The resultant objectives tree, as derived from the problem tree, is shown in Figure 22. To achieve acceptable pollutant emissions from the petrochemical industry, best practice management techniques need to be introduced to ensure that fugitive emissions from the waste dumps and stockpiles are minimised. Emissions from the combustion process can be minimised based on Best Available Techniques (BAT).

Trained and skilled personnel, with relevant air quality experience, need to be employed in the petrochemical industry, which will enable the industry to address their air quality matters. Effective governance, through the introduction of all sections of AQA, and enforcement of thereof, will ensure that emissions from this source are appropriately regulated and controlled. As per the requirements of AQA, an AEL will be issued which will include all sources of emissions from a specific industrial site, including both point and non-point sources. Although, minimum emission limits will be set nationally for all listed activities, AELs will have site specific emission limits based on the cumulative off-site concentrations resulting from an industry. Therefore, the licence will be based on the receiving environment as the focus point.

In addition, current monitoring and reporting practices need to be coordinated and this information disseminated to the appropriate authorities i.e. Local and National Government.

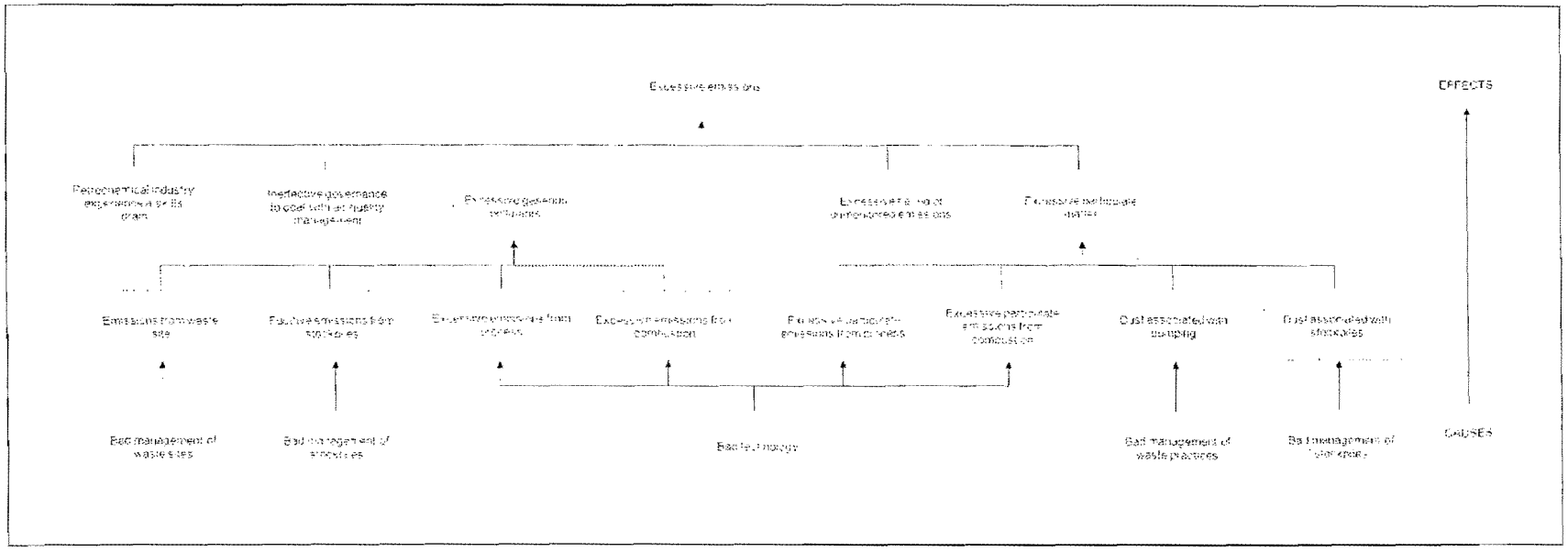

Figure 22: Problem Tree for the Petrochemical Industry.

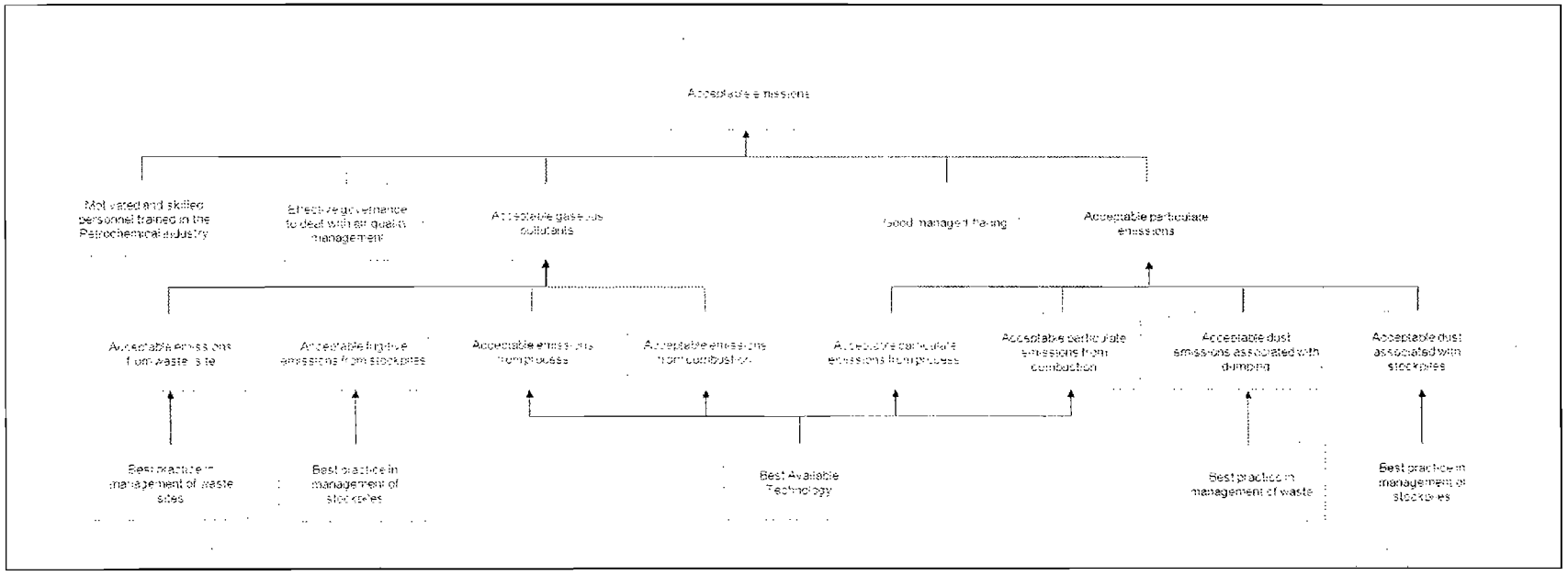

Figure 23: Objectives Tree for the Petrochemical Industry.

4.6 Power Generation

Lethabo power station is the only power generating source within the VTAPA.

4.6.1 Problem Analysis

Problems associated with the power generation industry are related to the use of low grade coal in coal-fired power stations. The low calorific value (CV) and high ash content of the coal results in large quantities of coal being burnt and resultant gaseous and particulate emissions. Sources of fugitive emissions include the coal stockpiles and ash disposal dumps.

4.6.1.1 Problem Cause

The main problem associated with coal-fired power stations is that these stations are designed to burn low grade coal and a result, large quantities of coal is burnt, which generates significant particulate and gaseous emissions. Lethabo Power Station is designed to burn low grade coal and is fitted with Electrostatic Precipitators (ESP) and Flue Gas Conditioning plant to reduce fine particulates. Even though this is a very effective method to reduce particulate emissions, overburden of the ESPs cause these not to function optimally resulting in higher particulate emissions. It also causes more frequent start-up and shut-down situations resulting in upset conditions (releasing uncontrolled emissions to air). Lethabo is also one of the main contributing sources to SO_2 ground level concentrations and should reduce by up to ~58%. The control of gaseous emissions, in particular SO_2 emissions, is limited by factors such as resource availability (for example, sufficient quantities of water) and plant design constraints.

Significant quantities of dust are also generated as a result of wind-blown dust from the coal stockpiles and from active and unrehabilitated ash disposal dumps. Dust is also generated during the loading and unloading of coal and during materials handling operations. Significant emissions arise due to the mechanical disturbance of granular material from open areas and storage piles. Parameters which have the potential to impact on the rate of fugitive dust emissions include the extent of surface compaction, moisture content, ground cover, the shape of the storage pile, particle size distribution, wind speed and precipitation.

The potential distance that dust particles can travel is governed by the initial injection height of the particle, the terminal settling velocity of the particle and the degree of atmospheric turbulence. For mean wind speeds of 16 km/hr, particles larger than 100 μm will be deposited within 6 – 9 metres from the source. Particles 30 – 100 μm in diameter will be deposited at far greater distances, while the deposition of smaller particles (PM_{10}) is dependent upon atmospheric turbulence (USEPA, 1995).

Other external problems influencing the power generation industry are related to the rapid increase in electricity demand and insufficient infrastructure to meet the current and future energy demands. As a result of these system constraints, there are fewer opportunities for maintenance and improvements of the plants.

Also, limited understanding and awareness about the power generation industry has meant that Eskom receives numerous complaints from the public about emissions from their wet-cooling plants. The current perception is that the steam emitted from the cooling towers is pollution.

4.6.1.2 Resulting Effects

The resultant effect of the identified problems is non-compliance of the power generation industry with some of the ambient air quality objectives due to excessive particulate and gaseous emissions from this source.

4.6.2 Objectives

The objectives tree is given in Figure 25 for the power generation industry. The main objective for the power generation industry is to reduce emissions to acceptable concentrations i.e. below the ambient air quality objectives where health impacts are minimised.

Although it is recognised that existing coal constraints and station design have a major impact on emissions from coal-fired power stations, using better quality coal for example (with lower ash content) will reduce the amount of coal burnt. In turn, this will reduce the burden on the Electrostatic Precipitators resulting in optimal control efficiency and lower down-times (upset conditions). By burning less coal the SO_2 emissions will also decrease. It is understood that the control equipment has no implication on the amount of coal used and therefore the objective should be to improve on the efficiency and availability of the control equipment and the quality of coal.

To minimise emissions from the coal stockpiles and ash dumps, best practice management techniques must be introduced to reduce wind-blown dust from these sources. Also, dormant ash dumps should be rehabilitated. Measures to reduce wind-blown emissions from stockpiles and dumps include the use of water sprays which have a 50% control efficiency (CE), use of wind breaks (30% CE) or total enclosure of the stockpiles and dumps (99% CE). Similar techniques can be used to reduce emissions during loading and unloading (Holmes Air Sciences, 1998). In addition, with the introduction of AELs, appropriate mitigation measures and procedures can be stipulated for fugitive sources with a specific control efficiency that must be achieved

New diversified installed capacity on the system will ensure that Eskom can meet the current and future energy requirements. This will reduce pressure on the system and in turn, provide for more maintenance and improvement opportunities. This will ensure that the system is operating efficiently and effectively and will contribute to a reduction in emissions.

The installation of continuous emissions monitoring systems will provide an indicator to determine compliance with emission limits. Similarly, the implementation of ambient monitoring stations will provide the data for compliance assessment with ambient air quality limits.

Also, the public need to be educated about the operations at a wet-cooling plant, so that they recognise that emissions from the cooling towers are in fact a loss of energy (as steam) rather than air pollution. Eskom will then receive fewer uninformed complaints about their plant processes.

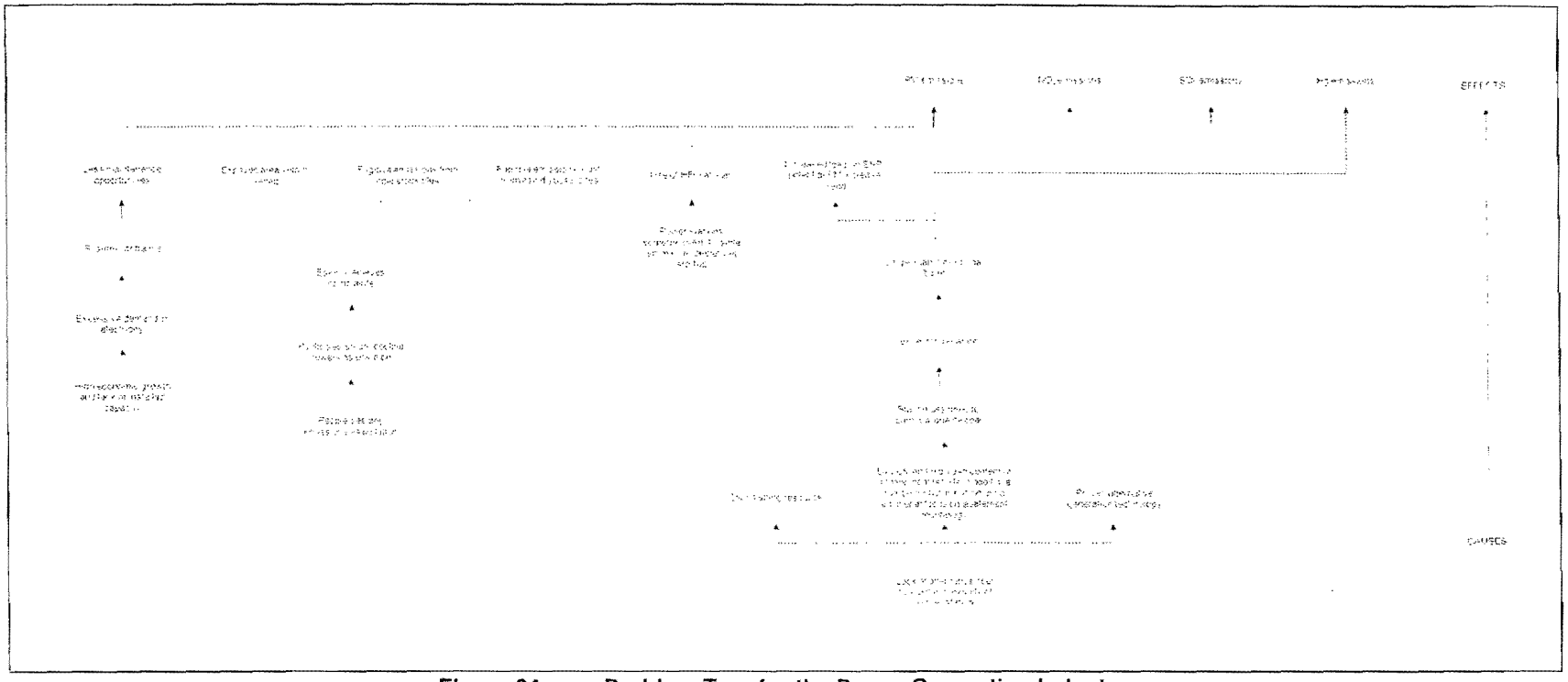

Figure 24: Problem Tree for the Power Generation Industry.

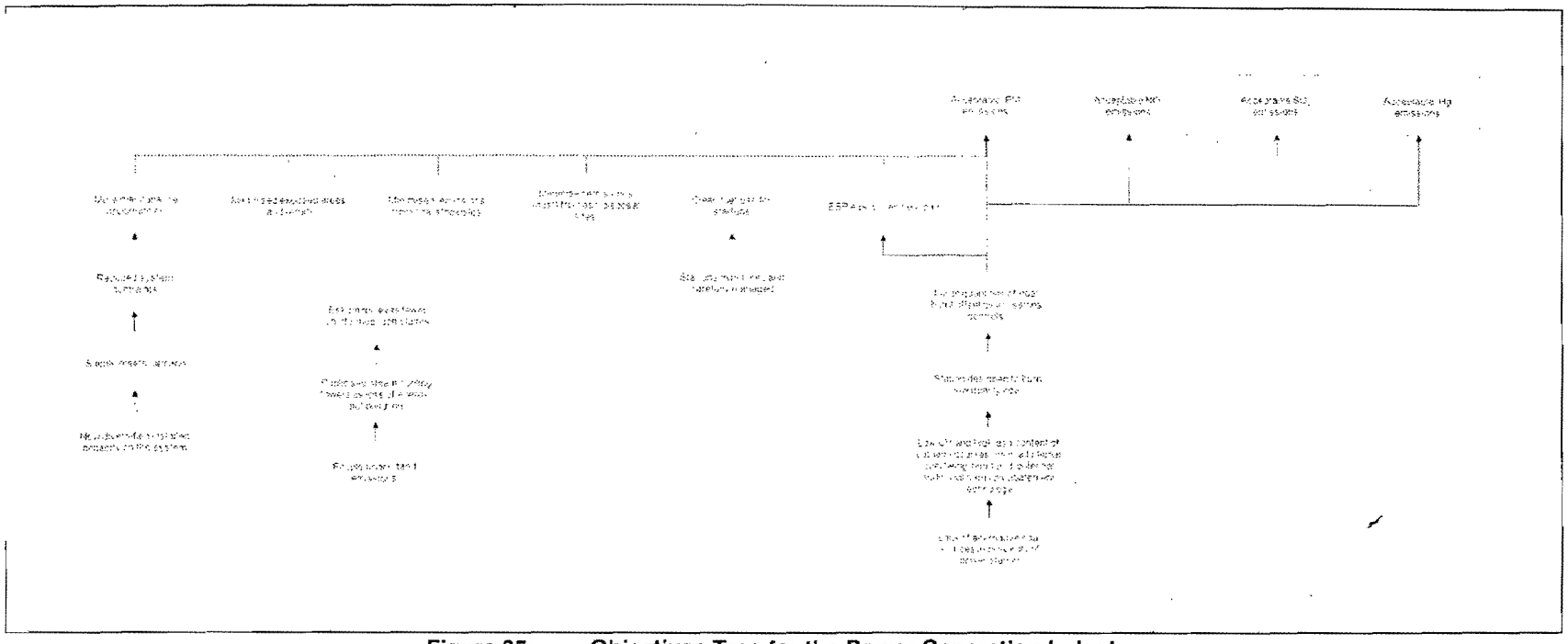

Figure 25: Objectives Tree for the Power Generation Industry.

4.7 Small Industries

Various fuel burning appliances, including boilers at schools and hospitals, pizza ovens, stand-by generators, air heaters, (etc.) are located within the VTAPA.

4.7.1 Problem Analysis

Emissions from small industrial sources are often uncontrolled and unregulated and as a result, emissions are unquantifiable. These sources generally have low stack heights with related poor dispersion potential. Therefore, pollutants released from these sources tend to have a localised impact. The problem tree for this particular problem complex is provided in Figure 26.

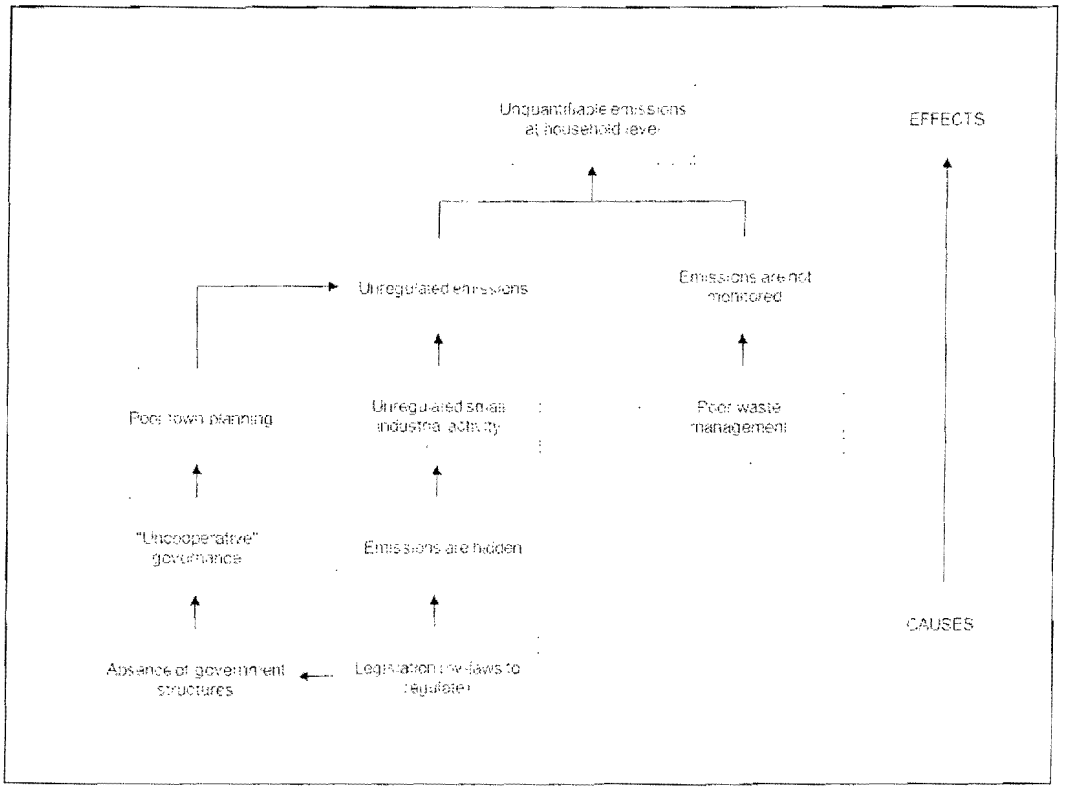

Figure 26: Problem Tree for Small Industries.

4.7.1.1 Problem Cause

With the previous absence of legislation and regulations to effectively manage emissions from small industrial operations, the impact of these sources on the ambient air quality is largely un-quantified. Few databases exist of these sources in the region, and where available, these databases are outdated or incomplete.

The absence of legislation such as by-laws and limited capacity in Government for control and enforcement, allows emissions from these sources to remain hidden and unregulated. Poor town planning has also resulted in the location of these sources in close proximity to residential areas where health impacts are the greatest.

4.7.1.2 Resulting Effects

The main effect of the non-regulation of small industrial operations is that emissions from this source are not quantified, and therefore the impacts on the environment and health remain largely unknown.

4.7.2 Objectives

The objectives tree for the above problem tree is given in Figure 27. Due to the localised nature of emissions from this source, the main objective is to achieve acceptable local air quality in close proximity to these sources. This can be achieved through the compilation of a detailed emissions inventory of small industrial sources, which will ensure that all these sources are characterised and quantified within the region. Proper regulation and regular monitoring will ensure that these sources are in compliance with the ambient air quality targets. Air quality management needs to be integrated into future town planning schemes to ensure that future industrial developments are appropriately located and are not in close proximity to residential areas. This will need to be strictly enforced by Government to ensure that these future town planning initiatives are implemented.

With the introduction of AQA, these sources can be declared as controlled emitters if considered to have a significant environmental and health impact. Provision is also made in AQA for the setting of emission standards for controlled emitters.

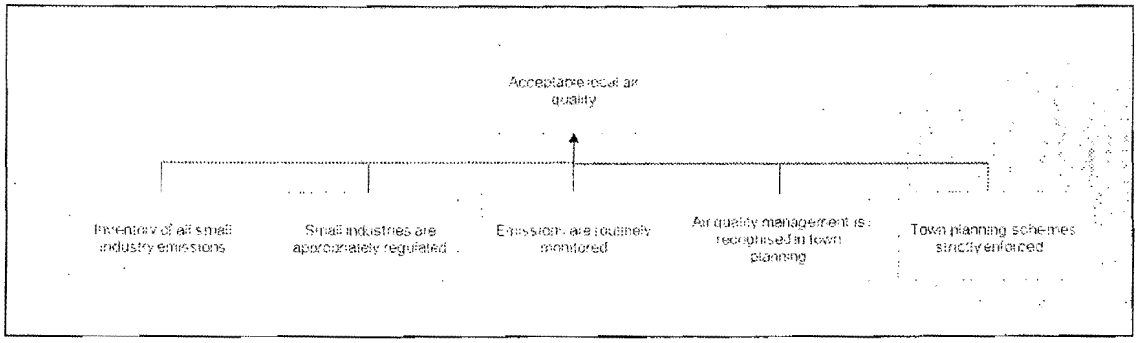

Figure 27: Objectives Tree for Small Industries.

4.8 Transportation

Air pollution from vehicle emissions may be grouped into primary and secondary pollutants. Primary pollutants are those emitted directly into the atmosphere, and secondary, those pollutants formed in the atmosphere as a result of chemical reactions, such as hydrolysis, oxidation, or photochemical reactions. Emissions from vehicle derive primarily from petrol or diesel combustion.

4.8.1 Problem Analysis

Emissions from vehicles are a major contributor to poor ambient air quality in many local and international cities. Although vehicles were not identified to be a major source in the Vaal Triangle region, the potential exists for

emissions from vehicles to significantly contribute to the ambient air quality within the future years. The problem tree developed for the transportation sector is shown in Figure 29.

4.8.1.1 Problem Cause

An inefficient and unreliable public transport system has resulted in an increasing number of privately owned vehicles with the region. Despite this, a significant proportion of the population are still reliant on public transport, with taxis as the main mode for public transport due to problems surrounding other forms of public transport such as the railway network. In addition, insufficient infrastructure exists due to poor town planning resulting in numerous problems such as traffic congestion specifically within residential areas. The proliferation of heavy vehicles on the local road network to transport heavy/bulk materials has also led to traffic problems in the region. As a result of increasing traffic volumes, congestion is experienced along the major roads. More time spent idling in traffic results in more emissions. This, combined with refuelling emissions from filling stations and poor quality fuel, results in high emissions from petrol and diesel driven vehicles. In addition, the limited enforcement of vehicle roadworthiness and poor vehicle maintenance has resulted in a predominantly older vehicle fleet, which also contributes to increased emissions.

4.8.1.2 Resulting Effects

Emissions from petrol and diesel driven vehicles have the potential to significantly impact the ambient air quality in the region, which will in turn have environmental and health impacts. Emissions from vehicles have also been recognised to be a major contributor to urban smog, which can contribute to visibility impairment.

4.8.2 Objectives

Achievable for the identified problems are shown in Figure 29. In order to reduce emissions from vehicles, improvements in the vehicle fleet and measures to reduce petrol and diesel emissions need to be implemented. An efficient and reliable public transport system is needed, which will decrease the number of privately owned vehicles. With improvements realised in the public transport system, other forms of transport such as taxis can become an optional mode of transport. Improved and informed town planning will allow for adequate infrastructure for future transport developments. A reduction in the number of heavy vehicles on the roads can be realised through the transport of heavy/bulk materials on a time efficient and reliable rail network. With the achievement of these objectives, congestion can be alleviated and less time can be spent in traffic. The installation of vapour recovery equipment at filling stations can reduce emissions associated with refuelling. These measures, together with an improvement in fuel quality, will reduce vehicle emissions from petrol and diesel driven vehicles. With the introduction of vehicle and fuel regulations and better vehicle maintenance, the current vehicle fleet will be replaced with new, well maintained vehicles. This will, in turn, have an effect on vehicle emissions as a whole.

With the introduction of AQA, vehicles can be declared as controlled emitters if considered to have a significant environmental and health impact. Provision is also made in AQA for the setting of emission standards for such controlled emitters.

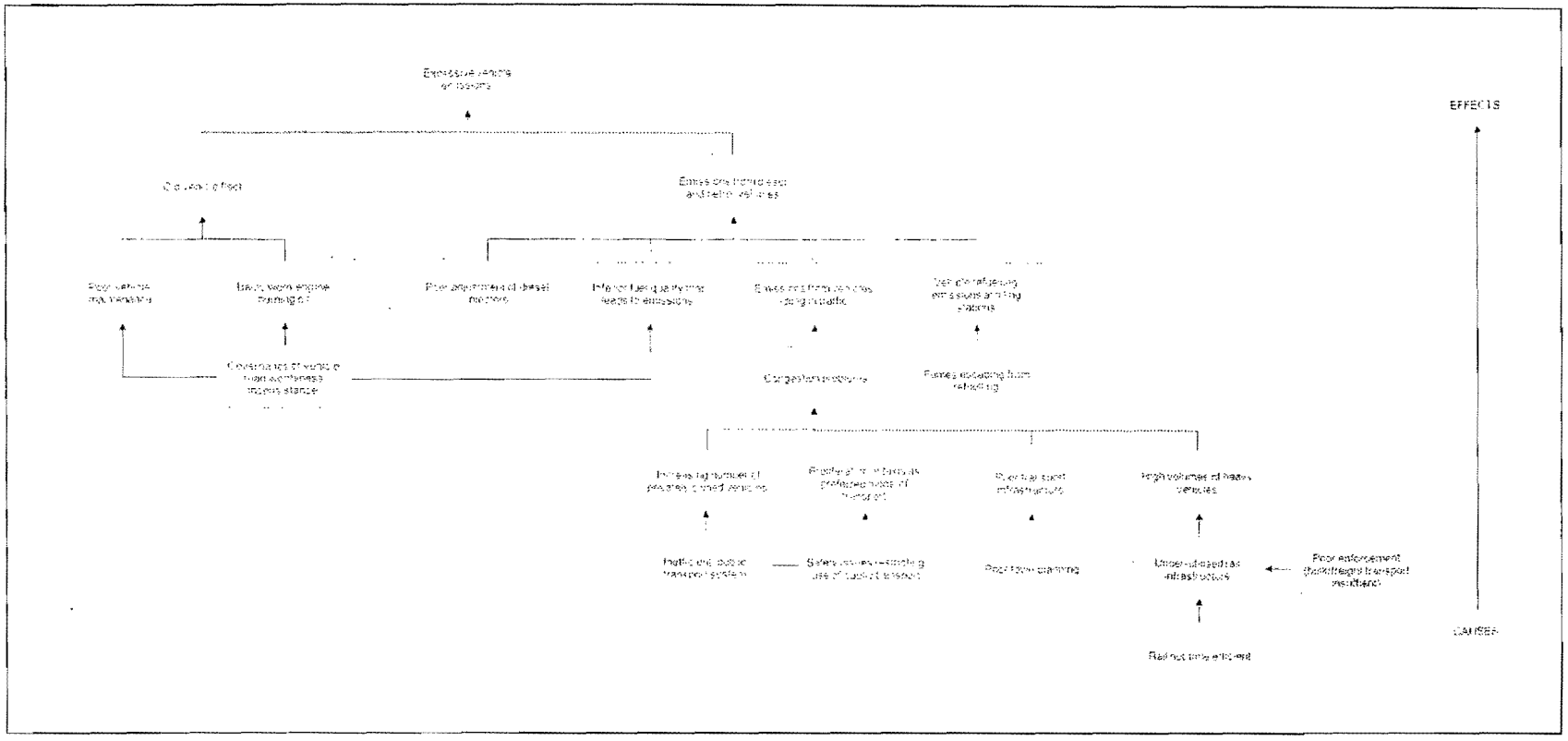

Figure 28: Problem Tree for the Transportation Sector.

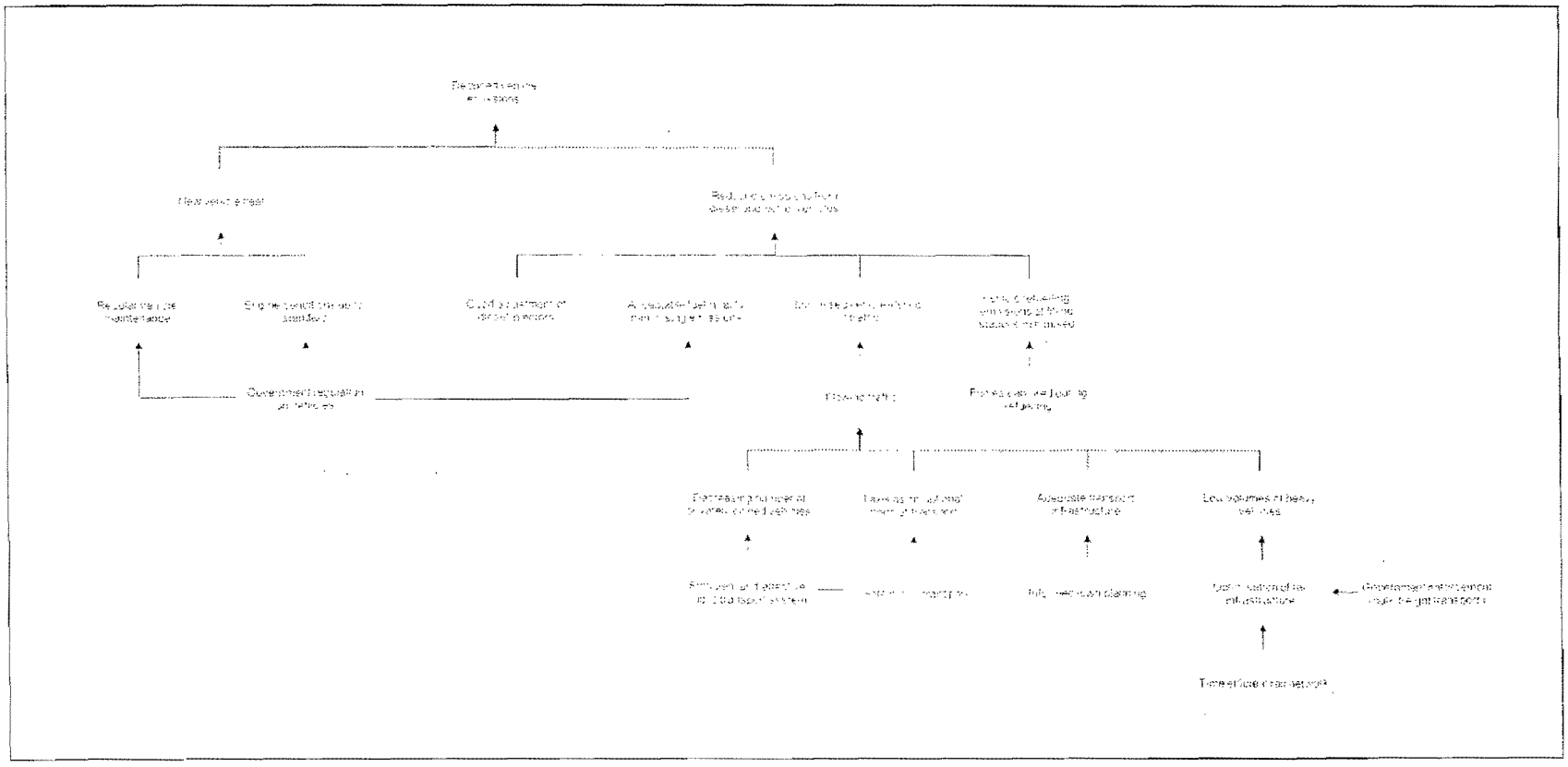

Figure 29: Objectives Tree for the Transportation Sector.

4.9 Waste Burning

Heavy metal, dioxin and furan emissions from waste incineration represent a considerable air quality and health risk concern related to such operations. Particulate emissions from incinerators may also comprise heavy metals such as chromium and cadmium, which are suspected human carcinogens. Emissions from waste incineration processes are directly related the type and amounts of waste. This level of detail was not available for the Baseline Assessment but based on the potential significance of the source it was included as a problem complex.

4.9.1 Problem Analysis

The burning of waste (animal, medical, tyres and domestic) generates air pollution in the form of greenhouse gas emissions, smoke, dioxins as well as odorous emissions. Ineffective and inconsistent municipal waste collection services in many informal areas promote the burning of domestic waste. The problem tree for this problem complex is given in Figure 30.

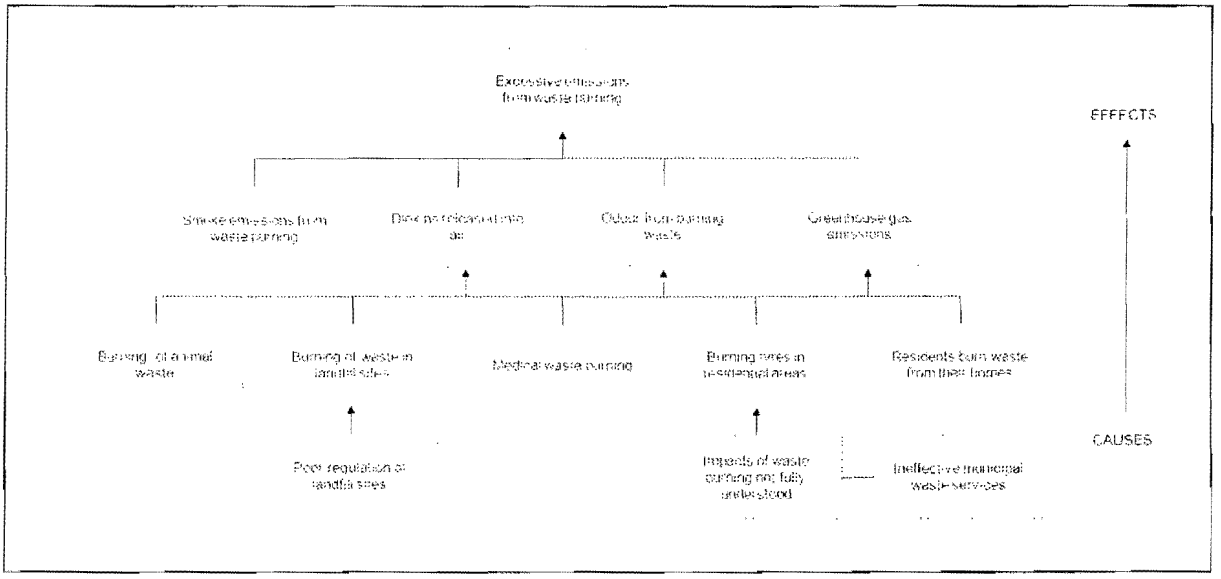

Figure 30: Problem Tree for Waste Burning.

4.9.1.1 Problem Cause

The burning of waste (animal, medical, tyres and domestic) generates air pollution in the form of greenhouse gas emissions, smoke, dioxins as well as odorous emissions. Ineffective and inconsistent municipal waste collection services in many informal areas promote the burning of domestic waste in these areas. Tyre burning, for heating purposes, as well as to remove the copper wire in the tyres, produces significant particulate emissions, which are visible as a dark black smoke. However, due to the informal nature of this source, it is difficult to quantify the extent to which this occurs and the environmental and health impacts of this source.

In addition, the poor regulation and management of landfills results in the formation of many small unpermitted landfill sites, in which uncontrolled waste burning occurs. People living in and around these landfills are exposed

to toxic and odorous gases when this occurs. Formal and informal medical waste incineration represents a significant air quality and health impact as toxic gases such as dioxins and furans are emitted when this occurs. Particulate emissions are also comprised of heavy metals such as chromium and cadmium, which are suspected human carcinogens. Other forms of waste incineration, such as the burning of animal waste received from abattoirs, are also often uncontrolled and un-quantified.

4.9.1.2 Resulting Effects

The un-quantifiable nature of emissions from waste burning results in an air pollution source that is difficult to regulate and control, and therefore generates significant quantities of particulate and gaseous pollutants.

4.9.2 Objectives

The overall objective for this particular source is to have acceptable emissions from waste burning. Individual objectives have been determined for each of the above identified problems to address all forms of waste burning in the Vaal Triangle.

Informal waste burning in residential areas can be reduced through effective and efficient municipal waste collection services. In addition, education and awareness around the air quality and associated health impacts of waste burning needs to be developed so that people understand the impacts of their activities.

To minimise emissions from uncontrolled burning in landfill sites, all landfill sites must be regulated and permitted. These landfills should meet the Department of Water Affairs and Forestry (DWAF) minimum requirements. Depending on the landfill classification and size, requirements may include:

- Various types of landfill lining and capping systems
- Operational controls
- Gas monitoring and management systems
- Restrictions on methane concentrations.

The regulation and control of medical waste incineration will reduce emissions from this source. An investigation into the legal status of all medical waste incinerators in the region should be conducted.

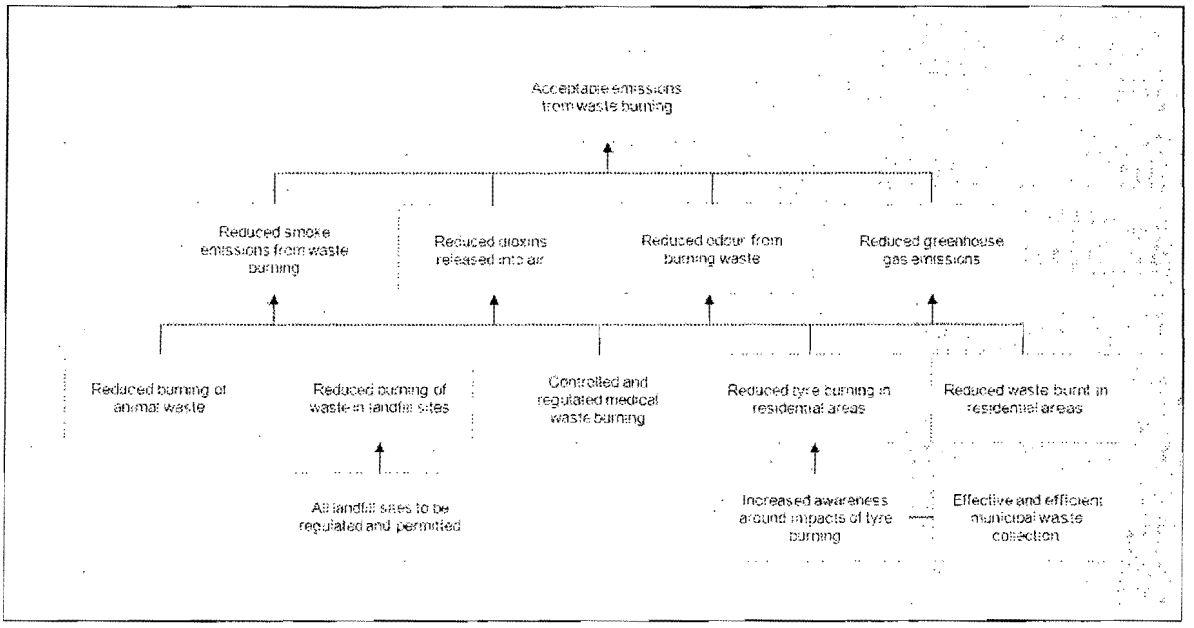

Figure 31: Objectives Tree for Waste Burning.

4.10 Information Management

4.10.1 Problem Analysis

The availability and dissemination of air quality information is a major obstacle affecting air quality management and control. Very little historic air quality monitoring data is available in the region, with air quality monitoring historically undertaken by the industries in the region. Data from the six recently installed DEAT monitoring stations will ensure that air quality in the region is effectively monitored, particularly in residential areas where the health impact is the greatest.

4.10.1.1 Problem Cause

Limited air quality data and information is available in the region, as the measurement of air quality has historically not been prioritised. In addition, current monitoring practices are not standardised and as a result, information is often scattered and fragmented.

In addition, insufficient data is collected and collated, with data not routinely transferred into information. However, information that is available is either not distributed or is purposely withheld. As a result, information is not sufficiently disseminated to interested and affected parties.

Other sources of information, such as emissions data, are also not easily accessible or available. Emissions from smaller industries are often un-quantified, as it is currently not a legal requirement. As a result, the quantification of total source emissions can be difficult and inaccurate.

Air quality research is also undertaken on a limited and fragmented scale within South Africa. This information is critical to extending our knowledge and understanding of air quality issues and atmospheric chemistry. Trans-boundary sources are also difficult to quantify and understand in terms of their impact on the current air quality situation in the Vaal Triangle Airshed.

4.10.1.2 Resulting Effects

Due to the limitations surrounding availability of existing information and appropriate dissemination of this information, air quality information is not readily available to stakeholders.

4.10.2 Objectives

The main objective is to ensure that information is readily available to stakeholders through sufficient data collection, collation and dissemination. The measurement of the ambient air quality needs to be prioritised by Government so that a comprehensive air quality monitoring network exists both in the Vaal Triangle region and across the country. These monitoring practices need to be standardised, with all stations SANAS accredited to ensure that data is of a high and accurate quality. Detailed source identification and quantification needs to be undertaken to ensure that emissions from un-quantified pollution sources are understood and characterised.

This monitoring and source information needs to be available and appropriately disseminated to interested stakeholders and public members. Data collection and collation needs to be undertaken through a coordinated approach, with all information captured in an electronic, centralised database. As part of the South African Air Quality Information System (SAAQIS) project that has been initiated by DEAT, all ambient air quality monitoring data will be transferred and stored in a centralised, electronic database at the South African Weather Services. If information is routinely created from data using appropriate data management and verification techniques, made freely available and widely distributed, there will be sufficient dissemination of information and all stakeholders will be informed.

Also, air quality research needs to be promoted and undertaken over a larger scale with South Africa. This will assist with the understanding of the impact of trans-boundary pollution sources on a particular airshed.

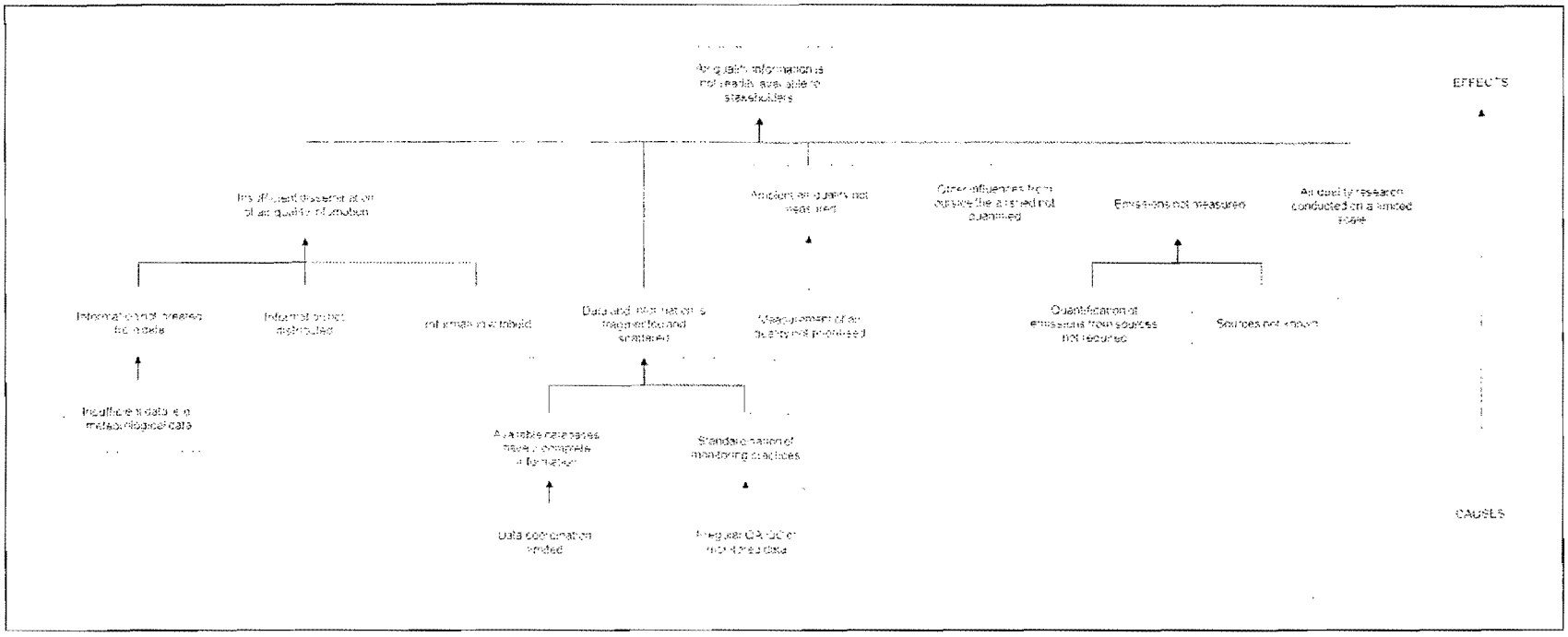

Figure 32: Problem Tree for Information Management.

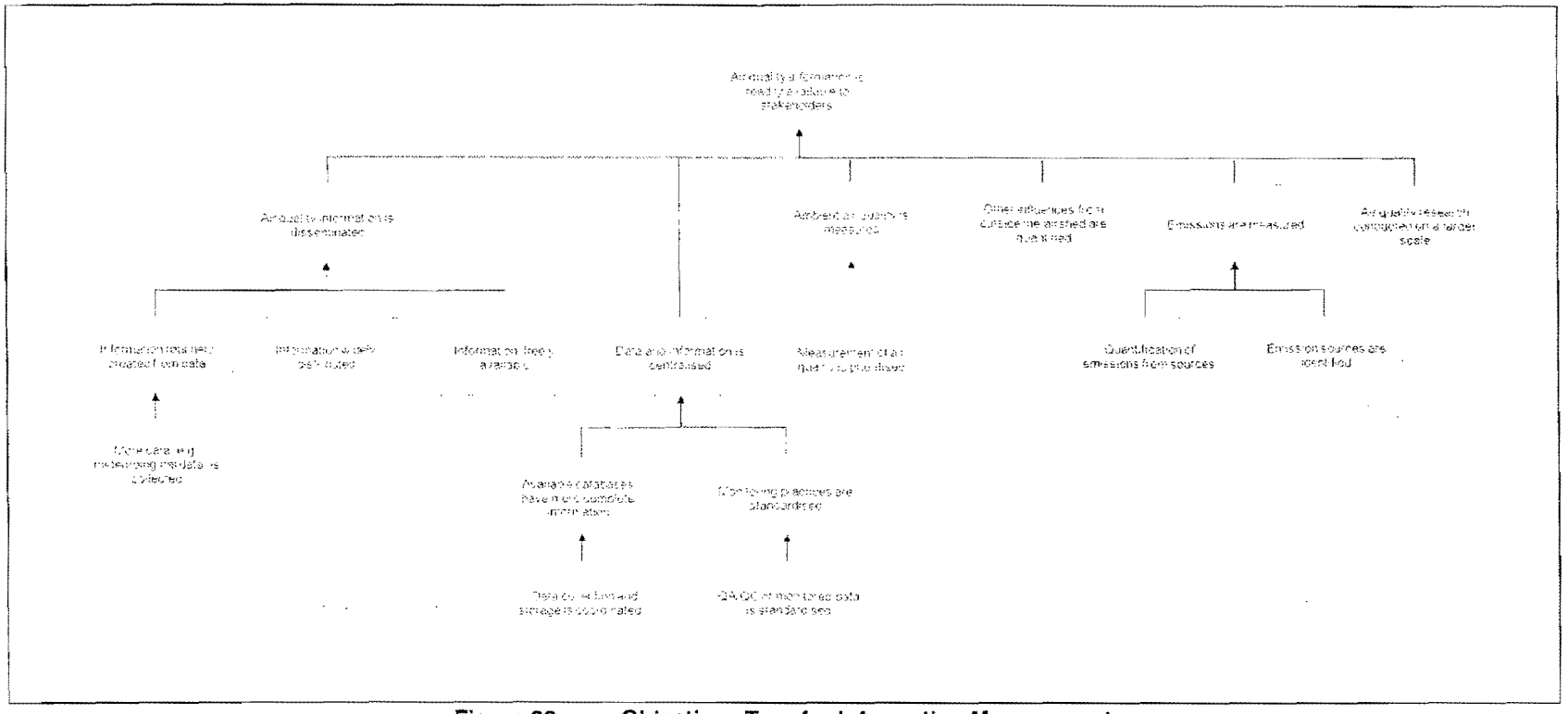

Figure 33: Objectives Tree for Information Management.

4.11 Governance

4.11.1 Problem Analysis

One of the major obstacles identified at the National, Provincial and Local Levels is capacity in terms of resources, tools and finances for air quality management and control. Current capacity for air quality management and control at Local Government within the Vaal Triangle needs to be addressed as Local Municipalities do not have the capacity or resources to undertake their required air quality management functions.

4.11.1.1 Problem Cause

With the introduction of AQA, air quality management responsibilities are transferred to Local Government. However, Local Municipalities currently have limited capacity for air quality management and control and as a result, air quality management is not prioritised. Additionally, air quality functions often form part of other environmental related functions, which limits the effectiveness of air quality management in the region. As a result, air quality management and control is addressed in an adhoc manner, which limits its effectiveness.

As National Government has been insufficiently resourced, previous air quality legislation (APPA) has become outdated and remains largely unenforced. Municipal by-laws also remain unregulated and unenforced and the lack of available information in priority areas has meant that air quality is poorly governed.

Unregulated atmospheric emissions, together with insufficient capacity and limited available air quality information, allows for uncontrolled emissions from pollution sources.

4.11.1.2 Resulting Effects

Limited capacity and resources in Government inhibits effective air quality governance and as a result, emissions from sources are uncontrolled and unregulated.

4.11.2 Objectives

The main objective is to ensure that emissions from pollution sources are controlled through good governance at a National, Provincial and Local Level. Through the prioritisation of air quality issues in Government, finances and resources will be made available and Government, in particular, Local Government, will be sufficiently capacitated for air quality management. A specific air quality division needs to be established within each level of Government whose specific functions are related to air quality management and control. Within this division, a trained Air Quality Officer and a technician need to be appointed. It is also recognised that in terms of AQA, different levels of Government have different functions. For example, the issuing of emission licences if primarily a function of the District and Metropolitan Municipalities while ambient air quality and emissions monitoring is a function of the Local Municipalities.

Once Government has sufficient resources, APPA will be repealed and the new AQA will be enforced. The promulgation and enforcement of municipal by-laws, together with available historic and current air quality information will ensure that sufficient knowledge exists to sufficiently govern air quality. Good regulation of atmospheric emissions, sufficient capacity and availability of air quality information will ensure that source emissions are effectively managed and controlled.

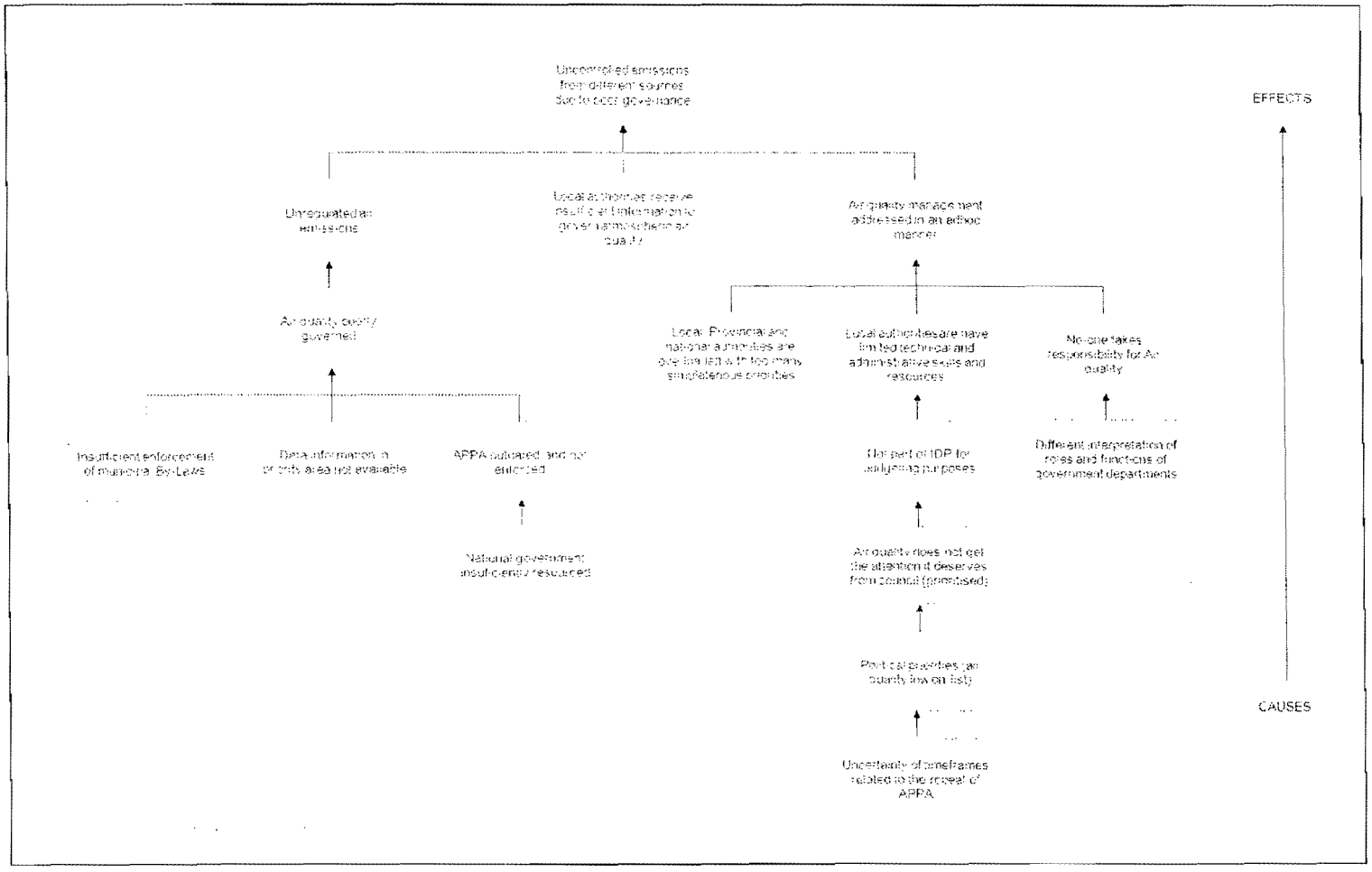

Figure 34: Problem Tree for Governance.

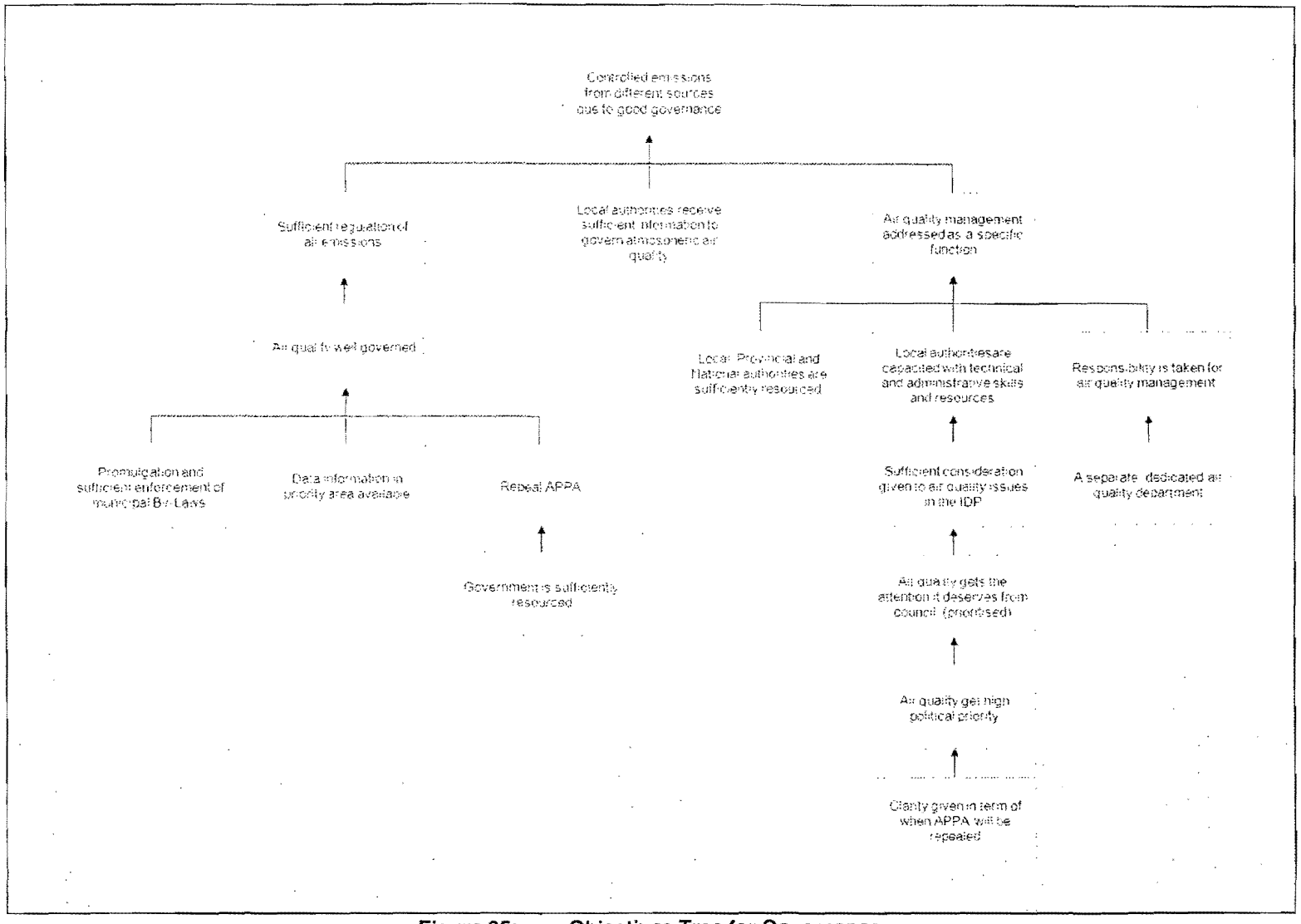

Figure 35: Objectives Tree for Governance.

5 STRATEGY ANALYSIS AND INTERVENTION DESCRIPTIONS FOR THE IDENTIFIED PROBLEM COMPLEXES

5.1 Strategy Analysis Methodology

Following the problem and objectives analysis, a strategy analysis was undertaken. Appropriate strategies were identified to develop feasible interventions to address the eleven problem complexes. It was recognised that these strategies should:

- Maximise use of existing information.
- Maximise use of national and international experience.
- Focus on the biggest social benefits for the least cost.
- Focus on air pollution hotspots.
- Maximise sustainability of interventions.
- Deal with lesser significant sources of pollution later.
- Fill information gaps where these create significant uncertainty.
- Maximise access to information.
- Maximise educational opportunities.
- Maximise community involvement.
- Maximise intergovernmental coordination and cooperation.

5.2 Intervention Description Approach

Various interventions have been proposed for each of the eleven problem complexes. As an outcome of the Baseline Assessment, problem areas were identified with related objectives formulated for each of the problem areas. Strategies to address the various objectives have been developed with related intervention descriptions for each. These interventions also incorporated the suggestions from stakeholders within the Vaal Triangle Airshed Priority Area, based on the output from the problem and objectives analysis. It was however, necessary to prioritise these interventions for implementation of the management plan, and since it was not possible to quantitatively evaluate these, criteria were adopted to qualitatively assess these options (taken from the NEDLAC Dirty Fuels study):

- **Environmental benefits**

  As a minimum, the measure must ensure the reduction of emissions, and hence improvement in ambient air quality. Options expected to achieve the following are preferred from an environmental perspective: (i) reduce ambient air pollutant concentrations, (ii) realise health risk reductions - including occupational and public exposures, (iii) and environmental risk reductions.

- **Technical viability**

  The option must preferably be practical and feasible under current conditions with the technology required for its implementation already available. (Options that require further development involve a higher degree of uncertainty.)

  Options which are based on proven technologies or methods are preferable to those using unproven technologies.

- **Degree of uncertainty**

  Preference is given to measures which are associated with a high degree of certainty with regard to measure implementation and environmental benefit realisation.

- **Social acceptability and desirability**

  The social acceptability of measures is an important indicator of the implementability of measures. Preference is given to measures which are not only socially acceptable but which are likely to be desirable to interested and affected parties and the general public.

- **Economic feasibility**

  The feasibility of the measure given the capital and operating costs associated with its implementation and the sectors responsible for covering such costs.

- **Strategic and political desirability**

  The acceptability of the measure given current legislation, regulations and strategies needs to be determined.

- **Timeframes for implementation and environmental benefit realization**

  Shorter timeframes are preferred, since lags in the management of significant sources increase the risk for public and environmental exposure.

- **Development of local expertise and potential for local employment**

  Minor considerations taken into account when comparing measures which are environmentally beneficial, technically viable and socio-economically acceptable.

As part of the overall strategy in the development of an AQMP for the VTAPA, the main sources contributing to the ambient air quality within the area were identified. Subsequently, the percentage reduction required in ambient concentrations from each of these individual sources was determined through dispersion modelling to ensure compliance with the VTAPA ambient air quality objectives (Section 5.2.1). It was not possible to determine emission reductions for each of these source groups, but merely ambient concentration reductions. The percentage reduction was based on the percentage contribution from each source group to the ambient air concentrations. It was agreed that each industry, mine and relevant body will assess the main contributing sources within their facility/group and determine the percentage emission reduction required to achieve the ambient air quality objectives.

The VTAPA AQMP will continuously be revised and updated to incorporate for example the following information:

- The revised National Ambient Air Quality Standards are undergoing the standard setting process and will be published in September 2009. The proposed standards are based on the SANS limit values which have been informed by International Best Practice (IBP). These proposed standards have been adopted as the VTAPA Air Quality Objectives but have no allowable frequency of exceedance linked to it. This will form part of the revised national standards.
- The Listed Activities and Minimum National Emission Standard Setting Project is in progress and are also going through the standard setting process. The proposed minimum national emission limits are informed by Best Available Techniques (BAT) and Best Available Control Techniques (BACT).
- The APPA Registration Certificate Review project reviewed current Registration Certificates for a number of industries of which the following are within the Vaal Triangle Airshed Priority Area:
  - Sasol Chemical Industries (SCI);
  - Natref Refineries;
  - ArcelorMittal (Vanderbijlpark Steel and Vereeniging Steel);
  - Davsteel (Cape Gate);
  - Samancor Meyerton Ferrometals; and,
  - Lethabo Power Station (Eskom).

Through this project the Atmospheric Emissions License (AEL) template and application form was developed. This template includes information requirements covering comprehensive emissions inventories, energy usage and strategies, and intervention strategies. The AEL will replace the current APPA registration Certificates once APPA is repealed in September 2009.

Since the minimum emission standards setting process are primarily informed by Best Available Techniques (BAT) and the understanding that most of the sources within the Vaal Triangle Priority Airshed have conducted air quality studies in the past (mostly as part of EIAs where technology reviews are part of the investigation), the development of emission reduction strategies should not be a difficult task once all the above mentioned projects are completed. It was therefore agreed that additional time be granted to the various industries within the VTAPA to develop detailed emission reduction strategies. Industry and government departments (National, Provincial and Local) were given until June 2008 to submit detailed emission reduction strategies ensuring compliance with ambient air quality objectives within given timeframes (Section 5.2.1). This information has been incorporated into the VTAPA AQMP.

General concerns voiced by stakeholders are listed below and have been incorporated into the intervention strategies in the short and medium term. The main concerns include:

- 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 of 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.

5.2.1 Vaal Triangle Airshed Priority Area Air Quality Targets

Given that the Vaal Triangle Airshed is a stressed area and has been the topic of concern over the past 15 years (Annegarn & Scorgie, 1997; Tereblanche, 1998; Liebenberg, 1999; Scorgie *et.al.*, 2004, Scorgie, 2004), meeting the current ambient air quality standards will not suffice. Therefore the compliance target during the baseline assessment for the VTAPA was based on a single exceedance of the ambient air quality objectives for the individual pollutants included (i.e. PM_{10}, SO_2, and NO_2) as reported in Table 7. Each pollutant was assessed individually, and PM_{10} was flagged as the main pollutant of concern, based on both the spatial footprint and magnitude of impact (i.e. frequency of exceedance was based on the 99^{th} percentile). Exceedances of SO_2 and NO_2 were also considered during the intervention descriptions.

The revised National Ambient Air Quality Standards will have allowable frequencies of exceedance linked to it and has been published for public comment on the 13^{th} of March 2009 (Government Notice 263 in Government Gazette 31987). The VTAPA Air Quality Objectives (AQO) proposes these as immediate targets to ensure air quality improvement. The VTAPA Air Quality Objectives (AQO) as listed in Table 26 proposes the revised

National Ambient Air Quality Standards as immediate objectives to ensure air quality improvement. These should be revised as soon as the National Standards are published in September 2009.

Table 26: Proposed Ambient Air Quality Implementation Objectives for the Vaal Triangle Airshed Priority Area

Averaging Period	Pollutant	Concentration	Frequency of permitted Exceedance (FOE)	Compliance Date [a]
1 hour	SO_2	350 $\mu g/m^3$	88	2009
	NO_2	200 $\mu g/m^3$	88	
	CO	30 000 $\mu g/m^3$	88	
8 hour	CO	10 000 $\mu g/m^3$	11	2009
	O_3	120 $\mu g/m^3$	11	
24 hour	SO_2	125 $\mu g/m^3$	4	2009
	PM_{10}	75 $\mu g/m^3$	4	
Annual	SO_2	50 $\mu g/m^3$	0	2009
	NO_2	40 $\mu g/m^3$	0	
	PM_{10}	40 $\mu g/m^3$	0	
	Lead	0.5 $\mu g/m^3$	0	
	Benzene	5 $\mu g/m^3$	0	

Notes: (a) Compliance date will be initiated when the revised National Standards are published in September 2009

5.2.2 Minimum National Emission Standards for Listed Activities

The Minimum National Emission Standards for Listed Activities are currently in draft form and undergoing the standard setting process through the South African Bureau of Standards (SABS). Industries had a good indication of where the emission standards are heading and were requested to base the emission reduction strategies on these minimum national emission standards. DEAT is in the process of modelling all the industrial sources based on these emissions standards. Should these minimum emissions limits prove to be inadequate in bringing the ambient air quality within VTAPA into compliance, more stringent emission limits will be set for each of the relevant industries. This rationale is explained in Figure 36. This process will form part of the AQMP review.

5.2.3 APPA Registration Certificate Review project

The revised APPA Registration Certificate (RC) has the look and feel of an Atmospheric Emissions Licence (AEL) as required under AQA. The certificate includes the proposed minimum national emission standards as the new emissions limits in the certificate. Timeframes for compliance with these more stringent emission limits have been included as explained above. The revised RC requires compliance with the new National Ambient Air Quality Standards or ambient air quality objectives for a district municipality or province (should these be more stringent than national). Therefore, the revised RCs (and eventually the new AEL) will require compliance with the VTAPA Ambient Air Quality objectives, limits and targets as set out in Section 5.2.1. Thus, DEAT reserves the right to use legal instruments to enforce compliance of the plan as reflected in Section 20 of AQA.

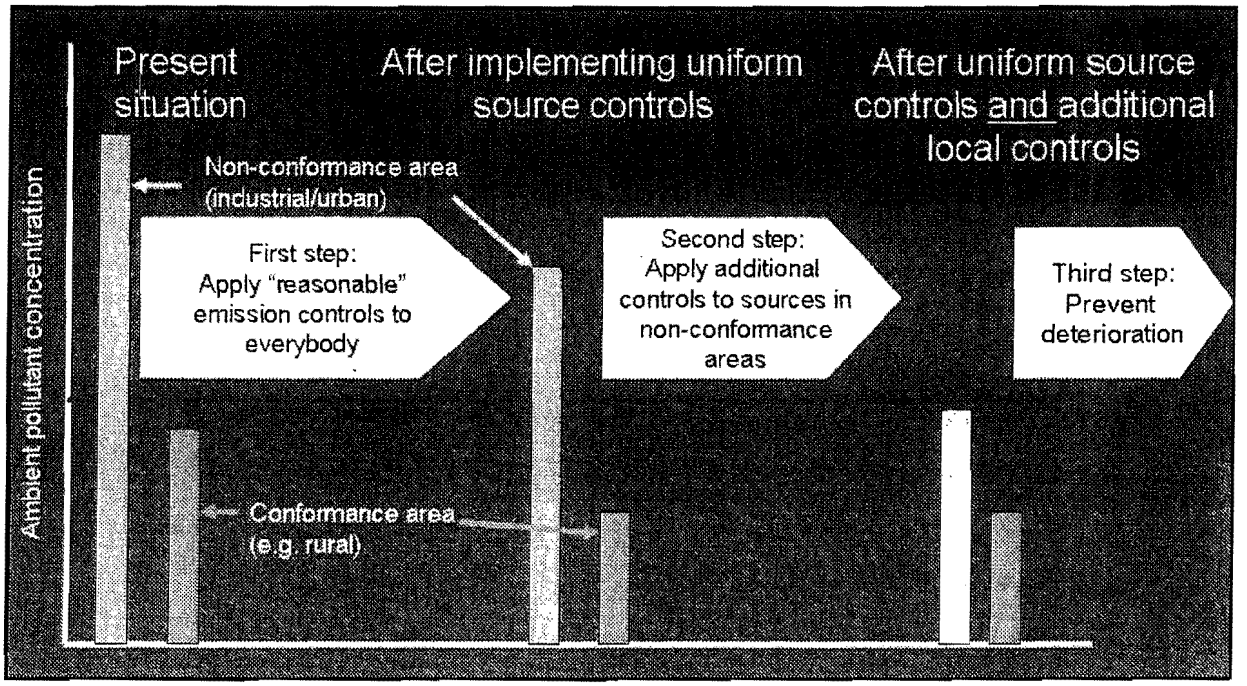

Figure 36: Proposed implementation framework for emission limits for listed activities (after G Kornelius, 2006).

5.3 Strategies and Intervention Descriptions for the Eleven Problem Complexes

The following subsections provide the strategies and intervention descriptions with associated timeframes for each of the eleven problem complexes. Action plans have been developed for selected sources and interventions (highlighted in yellow in each of the intervention tables) and are included in Appendix B.

Where possible, dates were assigned to each intervention. If dates were unknown, generic timeframes ranging from short-term (1 – 2 years), medium-term (3 – 5 years) and long-term (5 – 10 years) were assigned.

5.3.1 Biomass Burning

5.3.1.1 Proposed Emission Reduction Interventions

The seasonal and irregular nature of biomass burning makes characterisation difficult, and as a result, the contribution of this source to the ambient air quality in the region cannot be accurately determined. However, it is recognised that biomass burning has an impact on the local air quality, especially in terms of its particulate emissions. As a first step to quantify emissions, information on the locations of veld fires and areas burnt should be obtained from the local fire departments. In addition, satellite imagery is a useful tool to identifying burn scars which will provide information on the size of the areas burnt. The frequency and duration of fires are also important information. This information should then be used to simulate the potential impacts from veld fires.

In addition, practical measured that can be implemented to reduce the incident of unplanned fires is through controlled burning. Controlled burning will be a function of the local authority and will require controlled burning procedures to be developed as well as the monitoring thereof. This will require the identification of potential fire

hazardous areas such as large open areas specifically near residential areas. With controlled burning the time of day and season (beginning of the dry season) when burning can be managed to ensure it occurs during good dispersion potential periods. The areas to be burnt can be kept small in order to reduce the contribution to ambient air emissions. Public awareness of not just the danger of uncontrolled veld fires but also the implications for air quality should be raised. This can be done through community forums, media campaigns (i.e. television, radio, newspapers and magazines), advertising on bill boards and at railway stations and taxi ranks.

The implementation of measures to minimise or prevent emissions is recommended in Table 27. These recommendations include the development of an inversion early warning system that is linked to a veld fire control response. The local fire departments should be linked to this system and should continue to be made aware of scheduled burns. Research should also be initiated into international best practice regarding the practice of burning. The action plans developed for the highlighted interventions is provided in Appendix B, Table 50.

Table 27: Emission reduction interventions for biomass burning.

Intervention	Responsible Party	Timeframe	Progress
Identify the role of fire services to assist in air pollution control.	SDM, FDDM,, COJ	Short Term (2009)	SDM – coordinate and collaborate with local municipalities. LMs to combine inspections with fire services to enforce air pollution control and data capturing. FDDM – Community, health and Environmental Services engage in Local Municipality Fire Departments. Section 78 underway to investigate DM to take over fire services
Develop an inversion early warning system that triggers a veld fire control response (as obtained from the meteorological data measured in the VTAPA)	DEAT	Short Term (2009)	DEAT – the system has not yet been developed
Identify and quantify emissions from biomass burning and include into VTAPA Emissions Inventory	DEAT, DM, FDDM, COJ	Short – Medium Term (2012)	DEAT – biomass burning estimate techniques refined for GHG inventory. To investigate if methodologies can be replicated for pollution emissions. SDM – AQM sub directorate to coordinate. Recording biomass incidents in LMs. FDDM – will form part of AQMP to initiate last quarter 2008
Research into international best practice regarding controlled / prescribed burning	SDM, FDDM, COJ	Short – Medium Term (2012)	SDM – AQM sub directorate to coordinate. FDDM – will form part of baseline for AQMP to initiate last quarter 2008
Regional scheduled burn areas that are published for agricultural and management fires	GP & FSP	Short – Medium Term (2012)	
Develop procedures for local authorities to conduct controlled / prescribed burning	DEAT	Short – Medium Term (2012)	

Intervention	Responsible Party	Timeframe	Progress
Each local Fire Department to maintain and update a database of the locations of veld fires and the extent of the areas burnt.	SDM, FDDM, COJ	Short – Medium Term (initiation) - ongoing	SDM - LMs, the Fire Department keeps record and is available on request. Formulating monthly & quarterly stats from incidents. FDDM – Community, health and Environmental Services engage in Local Municipality Fire Departments. Section 78 underway to investigate DM to take over fire services

Notes:
SDM – Sedibeng District Municipality
COJ – City of Johannesburg Metropolitan Municipality
DEAT – Department of Environmental Affairs and Tourism
LMs – Local Municipalities
FDDM – Fezile Dabi District Municipality
GP – Gauteng Province
FSP – Free State Province
DM – District Municipality

5.3.2 Domestic Fuel Burning

5.3.2.1 National Government Interventions

In 2003, the DME developed the Integrated Clean Household Energy Strategy. This strategy identified three phases; (1) REFINE current combustion methods and appliances, (2) REPLACE coal with electricity, Low Smoke Fuels (LSF), other alternative fuels and solar power and (3) REDUCE energy requirements of homes through the introduction of energy efficient methods (insulation and solar power).

More recently in 2005, the DME published the Energy Efficiency Strategy of the Republic of South Africa. This strategy allows for the immediate implementation of no-cost and low-cost interventions, as well as higher-cost measures with a short payback period. This strategy aims to make energy affordable to everyone, and to minimise the effects of energy usage on human health and the environment. An overall national target for energy efficiency improvement of 12% by 2014 has been set. Within the residential sector, a reduction of 10% in energy demand by 2014 has been set. Measures to reduce energy demand include the introduction of standards for housing and household appliances, energy labelling of appliances and awareness campaigns around the cost-benefits of energy efficiency within households. The approach is focused on energy efficiency in higher income areas and state-subsidised housing which will incorporate energy efficiency measures.

Electrification was voiced as the preferred intervention option by various stakeholders in the VTAPA. Experience has however shown that even after electrification coal and wood burning continues to be a preferred energy source, specifically for space heating in winter. Explanations offered for retention of the domestic coal/wood stove even after electrification includes: affordability, security of supply, and social preferences. From a direct, local health risk perspective electrification does have considerable benefits in terms of reducing local air pollution concentrations and resultant health risks when successfully implemented. Electrification is therefore currently adopted as one component of an integrated energy strategy which aims to meet the social requirements and economic circumstances (Scorgie *et.al.*, 2004).

The ***top down ignition method*** (called 'Basa Njengo Magogo') is considered a short – medium term solution to address domestic fuel burning. This method, meaning 'make fire like grandmother' is a top-down approach to fuel loading in mbawulas and stoves. In the classical bottom-up fire ignition approach, the order of preparing a fire is paper, wood then coal. In the 'Basa Njengo Magogo' method, the order of preparing a fire is coal, paper, wood and a few pieces of coal at the top. Smoke generated in the latter method is burnt as it rises through the hot zone, resulting in reduced smoke emissions. In 2004, the CSIR undertook controlled laboratory tests of the

Basa Njengo Magogo method to determine the reduction in particulate emissions. These tests demonstrated an 80% to 90% reduction in smoke emissions and a 20% reduction in fuel consumption.

National rollout of the Basa Njengo Magogo technology is currently in progress and aimed to continue until 2015. The DME piloted the Basa Njengo Magogo method in Orange Farm during the winter of 2003. A total of 19 425 houses were directly and indirectly targeted. Approximately 76% of households reported a reduction in smoke in their homes, 67% reported less smoke in the streets after one month of using this method and 99% of households reported a saving of R26 per week and half a 25 kg bag of coal per week. The number of households still using the method was assessed in 2005. Of the 8 300 households surveyed, retention was approximately 40% with approximately 64% and 61% of household reporting economic and health benefits.

The NOVA Institute in collaboration with Sasol piloted the project in Zamdela in 2003 with the aim to reduce smoke from domestic coal fires by 40%. The project was conducted in two phases:

- During the winter of 2003 the project was piloted in Zamdela wards 9 and 10 (3000 households) and in Leitrim (3000 households),
- During the winter of 2004 the project was implemented in the remainder of Zamdela (approximately 14 000 households).

The project reported a reduction in PM_{10} concentrations of the order of magnitude of 40%.

Insulations of homes aim to reduce energy needs specifically for space heating. Unfortunately, the main prohibiting factor in home insulation is costs and to date no affordable insulation material (which is in compliance with other criteria) has been found (Irurah *et al.*, 2000). The search for a suitable material is recommended as a next priority in the Draft Integrated Clean Household Energy Strategy (August 2000) with the other advantages of this measure, viz. social health and human dignity and cleanliness, noted as additional motivations for the implementation of this measure. A field experiment conducted in eMbalenhle during 1997/8 indicated reductions in indoor TSP concentrations between 5% and 30% (van Niekerk and van Niekerk, 1999; van Niekerk and Swanepoel, 1999).

The Department of Housing has a number of initiatives on energy efficient housing. Energy efficient design considerations for example include the orientation of the house during the planning and design stage. Northern orientation will ensure maximum utilisation of sun but with roof overhang to ensure less heat during summer months. Shading of windows by deciduous trees will allow shading during hot summer months and allow sun to filter in during winter months. Better insulation includes ceilings, plastering of walls and floors covered with concrete, clay or bricks. Units that share wall also provide insulation against heat loss and undesirable heat gain.

Stove maintenance and replacement proved not very successful in the past. The field experiment conducted in eMbalenhle however indicated that stove repairs could improve the indoor air quality (based on the TSP) up to 10% and new stoves can improve it by between 15% and 30%. A proper chimney alone could result in TSP concentration reductions of 15% to 25%. A combination of insulation, chimney and stove repair could have as high as 40% reductions in indoor TSP concentrations.

The DME has initiated the Low-Smoke Coal (LSC) Programme as early as June 1994 in its attempt to provide a cleaner energy source. The main objective of this project was the development of ***low smoke fuel alternatives*** and an evaluation of the technical, social and economic feasibility of each of these. A number of low-smoke fuels have been sourced in South Africa and these low-smoke fuels have been evaluated in terms of their technical performance, economic feasibility, emission reduction potential, air quality improvement and health risk reduction potentials, and social acceptability. None of the fuels proved however to comprise all of the attributes required to be a viable alternative to the use of bituminous coal within the household energy sector (Scorgie *et.al.*, 2004). Natural gas as a fuel alternative was however identified to result in significant reductions in

emissions should it replace coal and wood as energy source in domestic households. The only prohibiting factor is the cost of implementation.

Solar as renewable energy is probably one of the most favourable options due to South Africa's high solar radiation levels. Solar electrification of rural households on a large scale began already in 1999 with the launch of the Shell Renewables-Eskom joint venture project in the Eastern Cape. The project aimed to supply more than 50 000 households with photovoltaic (PV) systems within three years. Other projects include: Eskom's School PV Electrification Programme and the installation of PV systems at rural clinics by the Independent Development Trust. Due to the costs of solar thermal system and PV system installation, the implementation of these systems within low-income households will require subsidisation or the setting up of bank guaranteed loan schemes (Scorgie *et.al.*, 2004).

5.3.2.2 Local Government Interventions

The City of Johannesburg has developed a strategy for the reduction of domestic fuel burning emissions. Proposed short-term interventions to address domestic fuel burning within the COJ include the:

- Training and designation of Air Quality Officials as Environment Management Inspectors,
- Establishment of a domestic fuel burning emissions Working Group, which will have representatives from local, provincial and national government, the private sector, non-government organisations, government agencies and academic institutions. The main functions of the Working Group are:
    - To review the current and proposed initiatives within the COJ,
    - To review emission reduction measures suitable for implementation in the medium-term
    - To draft a Strategic Implementation Program
- Conduct a Baseline Assessment of fuel usage as part of the implementation of domestic fuel burning emissions mitigation programs in Alexandra and Jabavu,
- Development and distribution of education awareness material related to issues of air pollution.

Medium and long-term interventions include the:

- Review of emission reduction options such as energy efficient housing, solar water heating, low-smoke fuels, stove maintenance and replacement,
- Development and implementation of by-laws,
- Development of the State of Energy Report and the Climate Change and Energy Strategy for the COJ.

5.3.2.3 Proposed Emission Reduction Interventions

The proposed emission reduction interventions for implementation in the VTAPA are outlined in Table 28. The associated action plans for the highlighted sections are provided in Table 50. The required reduction in ambient PM_{10} concentrations as a result of domestic fuel burning is between 1% and 70%. For SO_2 the concentrations from this problem complex need to reduce by up to 55% and ~3% for NO_2.

Emissions from domestic fuel burning need to be accurately determined to ensure that its contribution to the overall ambient air quality in the region is accurately quantified. As part of the baseline assessment, a first step in the quantification of domestic fuel burning was undertaken. However, it is recognised that limitations to this assessment include the use of population and household fuel usage statistics from the 2001 census database. Therefore, it is critical that this emissions inventory database be updated as population statistics become available. The next population census has been planned for 2011. Based on the NEDLAC Dirty Fuels report of

2004, the total direct health costs (in Rand) in the Vaal Triangle (excluding the areas within COJ) due to domestic fuel burning of coal, wood and other fuels was R 320,494,346 comprising 83% of the total health costs in the Vaal Triangle. Thus, it is imperative that a comprehensive health risk assessment be conducted for the VTAPA based on actual hospital records and updated statistics.

The development and implementation of an awareness programme is critical to address the health risks associated with emissions from domestic coal and wood burning. This awareness programme should focus on changing people's understanding and behaviour towards domestic burning, and educate them on the benefits of using alternative options (these alternative must however be provided). This awareness campaign should be undertaken using all forms of available media including television, radio, newspapers and flyers, as well as through field campaigns and demonstrations with the affected areas. This information should be distributed on a regular basis, with annual updates on alternatives to cola usage and improvements within the low income areas. The top down ignition method known as the Basa Njengo Magogo method is regarded as a viable short-term solution in the attempt to reduce the health risks to people currently not having an alternative option to using coal. In addition, alternatives to the Basa Njengo Magogo method should be investigated and implemented, including the rollout of safer illuminating paraffin (IP) stoves. The rollout of these safer IP stoves has already been planned in selected areas in Gauteng and the Western Cape as part of the Central Energy Fund (CEF) Safer IP appliances pilot project. The implementation of solar and PV systems should be investigated as a priority option and it is recommended that DEAT collaborate with Eskom on the viability of these in the VTAPA.

In addition, the development of a VTAPA 'Clean Air Fund' has been recommended with the main aim of supporting community initiatives, as well as the prioritisation of the support from DEAT to address domestic fuel burning in the region.

The Vaal Environmental Justice Alliance (VEJA) has also provided a strategy for alternative renewable energy which is included in the interventions listed in Table 28. VEJA operates through four task teams namely; (i) energy and air quality, (ii) waste management, (iii) health and (iv) water. The proposed pilot project of appropriate renewable sustainable energy mix at Kwa-Masiza hostel complex aims to establish a multi-stakeholder participation group on air quality that can serve as a model for the Vaal and other previously disadvantaged areas.

A generic action plan for the domestic fuel burning sector is provided in Appendix A, Table 51.

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PART 2 OF 2

Table 28: Emission reduction interventions for Domestic Fuel Burning.

Intervention	Responsible Party	Timeframe	Progress
Implement a Vaal Triangle Area 'Clean Air Fund' to support community initiatives. The criteria, timeline and management should be agreed up front to minimise the risk of fund mismanagement	DEAT, SDM, FDDM, COJ	Short Term (2008/9)	SDM – all funds related to clean air initiatives are handled i.t.o. Municipal Finance Act. FDDM – to start discussions with local industries to consolidate their current individual funds towards air pollution management
Investigate short-term alternatives to Basa Njengo Magogo (BnM)	DEAT & DME	Short Term (2008/9)	
Undertake a project to investigate how to change behaviour regarding coal burning and educate people on the alternative and benefits associated with these	DEAT & DME	Short Term (2008/9)	
Investigate main reasons why electrified households still use other fuels	DEAT & DME	Short Term (2008/9)	DEAT – NOVA research (commissioned by the CD) indicated number of factors including appliances costs and effectiveness of coal as bulk energy carrier (both cooking & heating)
Promote human rights education programmes	DEAT & DME	Short Term (2008/9)	
Roll-out of safer illuminating paraffin (IP) stoves	DEAT & DME	Short Term (2008/9)	
Implement the BnM method (to reduce emissions by ~50% and safe on coal consumption costs of up to 20%) in: - Sebokeng, Sharpville, Zamdela, Soweto - Orange Farm, Evaton, Bophelong, Boipatong	SDM, FDDM, COJ together with DEAT & DME	Short Term (2008/9) Short - Medium Term (2012)	DEAT - Clean Fires Campaign implemented in various parts of VTAPA. Effectiveness of this project will be determined by the end of 2009. SDM – partner with Urban Environmental Program funded by Danish Government. Provision is made to appoint a service provider for such a project in 2008/9. Pilot study in Sharpville. Health awareness campaign in Sicelo & Lakeside.
BnM roll-out to be accompanied by extensive education on the dangers/negative impacts of in-house coal burning with real death rate statistics.	SDM, FDDM, COJ together with DEAT & DME	Short - Medium Term (2012)	DEAT - Clean Fires Campaign SDM (ELM) has obtained funds and is in the process of implementation. SDM - Health awareness campaigns in local newspapers & radio stations FDDM - ongoing

Intervention	Responsible Party	Timeframe	Progress
DEAT to prioritise Vaal Triangle Area Air Quality Project support in using its social response funds.	DEAT & DME	Short - Medium Term (2008 – 2012)	DEAT – no air quality project is funded by SRPP Directorate in this financial cycle. This will be initiated in 2009.
Initiation of the VEJA project on alternative energy mix for Kwa-Masiza, including: - Biomass: Kwa-Masiza has an old organic dump which can be used to generate natural gas - Solar Energy: Kwa-Masiza has four storey buildings on which solar panels can be installed. This can supply the entire Sebokeng with affordable electricity - Wind: Kwa-Masiza is an area is within the prevailing south-westerly wind zone and suitable for the erection of wind turbines that can generate electricity for the entire Sebokeng	DEAT, SDM, Industry & VEJA	Short - Medium Term (2008 – 2012)	VEJA has initiated the project and has already started a research proposal. A workshop is planned for the 15th of September 2008 at Bophelong. The evaluation of the plan will be done on a continuous basis by the Energy & Air Quality task team, the VEJA Steering Committee and the Vaal Community assembly.
Review domestic fuel burning emissions inventory with updated population statistics as these become available.	DEAT	Medium Term (2012)	DEAT - has appointed a service provider to compile a comprehensive emissions inventory for GHG. Review after completion of the project.
Implement an awareness raising programme through media campaigns and community forums	DEAT	Short - Medium Term (2012)	
Introducing low smoke fuels (based on the assumption that a plant will be established to produce LSF in the VTAPA)	DME	Medium Term (2012)	DME - is developing a standard for LSF together with SABS & look to provide less expensive LSD plant.
Undertake a comprehensive study on health risks associated with domestic fuel burning. This should be based on hospital records and updated population statistics	DEAT	Medium Term (2012)	DEAT – in the process of drafting project proposals
Identify alternative fuel sources as fossil fuel is not an indefinite or sustainable resource	DEAT & DME	Medium Term (2012)	
Investigate the feasibility of solar energy and why it is not advanced in South Africa. Eskom has experience in the form of the Shell Renewable–Eskom joint venture conducted in 1999.	DEAT & DME & Eskom	Medium Term (2012)	
Integrate energy efficiency measures in low-cost houses; such as: - Housing insulation. A search for suitable and cost effective insulation materials should be done in the short-term - Electrification of households - Stove maintenance and replacement (start with	DME (SDM, FDDM, COJ Housing Divisions) DEAT & DME DEAT & DME	Short - Medium Term (2008 – 2012) Short - Medium Term (2008 – 2012) Short -	Department of Health – initiated a project to investigate the feasibility of incorporating energy efficiency measures into low-cost housing. SDM – housing departments at the 4 LMs to be brought on board. Future projects to be advised on thermal efficiency methods

Intervention	Responsible Party	Timeframe	Progress
10% of coal burning households)		Medium Term (2008 – 2012)	FDDM – engaging provincial & local authorities
Notes:		FDDM – Fezile Dabi District Municipality	
SDM – Sedibeng District Municipality		GP – Gauteng Province	
COJ – City of Johannesburg Metropolitan Municipality		FSP – Free State Province	
DEAT – Department of Environmental Affairs and Tourism		LM – Local Municipality	

5.3.3 Iron and Steel/Ferroalloys Industry

The iron and steel industries and ferroalloy industries located within the VTAPA include the following:

- ArcelorMittal Vanderbijlpark Steel – Iron and Steel
- ArcelorMittal Vereeniging Steel – Iron and Steel
- Davsteel (Cape Gate) – Iron and Steel
- Samancor Meyerton – FerroAlloy

Of these industries, ArcelorMittal and Samancor Ferrometals were identified as the main contributing sources to PM_{10}. ArcelorMittal need to reduce ambient PM_{10} air quality concentrations resulting from the Vanderbijlpark Works by between 1% and 21% and SO_2 concentrations by ~6.5%. NO_2 concentrations need to be verified through monitoring but the predicted concentrations indicated a required reduction of ~23%. Samacor Meyerton must reduce ambient concentrations of PM_{10} between 1% and 44%.

5.3.3.1 ArcelorMittal South Africa Emission Reduction Strategy

ArcelorMittal South Africa Vaderbijlpark Steel has committed towards the minimisation of impacts from their operations on the receiving environment. ArcelorMittal South Africa Vaderbijlpark Steel provided a detailed Emissions Reduction Strategy as part of the review of the VTAPA AQMP.

The emissions reduction strategy aimed to determine a comprehensive emission baseline for all operations which form part of ArcelorMittal South Africa. A typical gap analysis approach was followed highlighting the main areas to focus the strategy on. The main findings from the gap analysis were:

- Gaps in ambient monitoring infrastructure;
- No data availability from minor point sources;
- Only monitored particulate emissions in the past with no monitoring done for gaseous emissions (SO_2 and NO_x);
- Due to the focus of APPA permits on emission concentrations only, other parameters required for an emissions inventory are not readily available;
- Quantification and management of fugitive emissions was not sufficient; and,
- Dispersion modelling of expected impacts on the surrounding environment and communities can be conducted more regularly as part of a risk assessment.

Ambient measurements of PM_{10} over the past few years indicated annual average concentrations higher than the VTAPA AQO of 40 $\mu g/m^3$. Fugitive emissions were identified as one of the main contributing sources at the Vanderbijlpark operations eliciting better quantification of these emissions. Even though the AQA is not fully implemented to date, ArcelorMittal South Africa decided to be pro-active and use the EU standards as benchmark, specifically for new projects.

The main sources of fugitive emissions at the Vanderbijlpark Works were identified as the coke batteries, secondary emissions from building roofs (including the electric arc furnace (EAF) building, the basic oxygen furnace (BOF) building and the blast furnace (BF) building). Off these, the coke batteries contribute about 43% of the total fugitive emissions. Specific strategies to address these emissions are provided in Table 29 and aim to reduce the total emissions by at least 50%.

Table 29: Emission reduction strategy for fugitive dust emissions

Project title	Project description	Target Emissions Reduction	Target Date
Roof emissions from Blast Furnace D	During the current reline of BF-D, the effectiveness of the primary extraction system was improved to capture a significant portion of the roof emissions from the cast house.	Fugitive particulate emission reduction = 300 tpa	Short Term (Completed 2007)
Dust suppression at waste disposal site	A dust suppression system, using high pressure to create a fine water mist, is currently being constructed at the waste disposal site to prevent dust transportation.	Fugitive particulate emission reduction = 70 tpa	Short Term (First phase – 2008)
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 openings in the roof.	Fugitive particulate emission reduction =f 500 tpa	Short Term (end of 2010)
Replacement of old Coke Batteries	Replace Batteries 1, 3, 6 and 7 with two larger batteries (10 & 11). These batteries will be "best available techniques "(BAT) and reduce emissions from door leaks, charging and pushing of coke. Batteries V4, V8 and V9 will continue to operate until 2020.	Fugitive particulate emission reduction expected to be 772 tpa (subject to further investigation)	Short - Medium Term (end of 2013)

Particulate and sulphur dioxide emissions from point sources are also addressed in the strategy (Table 30) aiming to reduce particulates by 70% and SO_2 by 48%. The main point source contributing to particulate emissions is the Sinter Plant at 55%, followed by the Direct Reduction (21%) and thirdly the Coke Ovens (14%). The Direct Reduction process is the main source of SO_2 emissions (25%), with the Hot Strip Mill second (21%) and the Sinter Plant third (18%).

Oxides of Nitrogen emissions are primarily a result of the reheating furnaces at the Hot Strip Mill (47%). Some of the abatement projects described to mitigate particulate and SO_2 emissions are likely to have some improvement impact on NO_x emissions, but this can be considered to be insignificant and the implementation of the coke strategy will even slightly increase NO_x emissions.

The main objective of ArcelorMittal South Africa Vanderbijlpark Works is to achieve ambient PM_{10} dust concentrations of 40 ug/Nm^3 by 2011 along its fence lines. Also it aims to reduce particulate emissions deriving from fugitive sources by 70% and from point sources by 5%, with SO_2 reductions of 48%. An action plan for ArcelorMittal is included in Appendix B, Table 52.

Table 30: Emission reduction strategy for point sources

Project title	Project description	Target Emissions Reduction	Target Date
Stoppage of dosing with spent pickling liquor at the Sinter plant	Past practices included Spent Pickling Liquor to be sprayed into the mixing drum forming potassium chloride (KC) which form part of the gas released to atmosphere. The removal of KCl particulates downstream proved ineffective and the practice was stopped	Fugitive particulate emission reduction = 5 107 tpa	(Completed - May 2006
Coke Oven Gas (COG) & Water Cleaning Plant Project	The technology was outdated and the COG & water cleaning project was initiated in 2003 to upgrade the system and reduce SO_2, NH_3 and HCN emissions.	SO_2 emission reduction = 5 686 tpa	Short Term (early 2009)
Direct Reduction (kilns) Electrostatic Precipitator (ESP) rebuild	Replaced the refractory linings that will improve the performance of the ESPs at the Direct Reduction kilns	Fugitive particulate emission reduction of 50 tpa	Short Term (November 2008)
Sinter Clean Gas Unit	Installation of emission abatement technology (bag filter system) to reduce particulate emissions from the entire Sinter Plant. The addition of lime to the off-gas will be introduced to effectively remove SO_2.	Emission reduction PM = 1 848 tpa SO_2 = to be confirmed	Short – Medium Term (date to be confirmed)
Replacement of old Coke Batteries	Replace Batteries 1, 3, 6 and 7 with two larger batteries (10 & 11). These batteries will be "best available techniques" (BAT) and reduce emissions from the combustion stacks. Batteries V4, V8 and V9 will continue to operate until 2020.	Emission reduction PM = 318 tpa SO_2 = 1 712 tpa	Short – Medium Term (December 2012)

Additional short-term objectives to be achieved in 2008 based on the gap analysis findings are as follows:

- Accuracy of emission inventories to be updated further during 2008 by making use of additional monitoring equipment that was invested in during 2007.
- Values obtained for fugitive emissions need to be reviewed during 2008.
- VOC and S-VOC emissions should be quantified with a high level of confidence at all BU's during 2008.
- CO and CH_4 emissions need to be quantified with a high level of confidence during 2008.
- Heavy metal emissions (Cr, Ni, Pb, Zn) need to be quantified with a high level of confidence during 2008 (from point and fugitive sources)
- Dioxin and furan emissions need to be measured at all BU's during 2008.
- Potential NO_x reductions need to be investigated at all operations, especially by installing "low NO_x combustion technology". Investigations to be completed by June 2008.

5.3.3.2 Samancor Meyerton (Metalloys) Emission Reduction Strategy

Samancor Meyerton has indicated their commitment to improve operations in order to reduce the ambient PM_{10} concentrations resulting from their plant. Samancor Meyerton also known as Metalloys is investing 15 million rand to ensure improvements at their current operations. Metalloys has already successfully implemented a number of emission reduction projects, including amongst others:

- Secondary Dust extraction systems at all plants;
- Membrane filter cloth with very low emission rates at all bag filter plants;
- Footprint reduction of raw materials and final products handling systems;
- Covered conveyor system for all raw material feeds to the furnace plants;
- Dust suppression (fogging) at certain materials management conveyor belts;
- Chemical dust suppression treatment of raw materials at the automated reclaimer system;

- Tar and concrete paving of major roads;
- Regular dust-a-side treatment of major haul roads on site;
- Rehabilitation of old phosphorus dams;
- Greening of open areas, tree screening of railway line towards the R59; and,
- Pelletising plant operation with reuses bag filter dust otherwise disposed of.

In addition, Metalloys embarked on a comprehensive project to compile an Emissions Reduction Strategy (ERS) to ensure the reduction of particulate emissions from their operations in a sustainable and cost effective way. During this project it was realised that the actual particulate emissions from Metalloys are substantially lower that what was included in the VTAPA Baseline Assessment. Emission reduction strategies already executed during 2008 are listed in Table 31.

Table 31: Emission reduction projects Financial Year 2008

Project title	Project description	Project cost	Implementation target date	Status
Rehabilitation of old North Sludge 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.	R5,000,000	06/2008	To be considered during integrated rehabilitation planning on 2008/2009
Dust suppression at Final Products Handling	Dust suppression by added moisture, screening and washing to remove fine materials, resulting less dust generation during dispatching	R5,000,000	06/2008	Completed
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.	R600,000	06/2008	Completed 08/2008
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.	R15,000,000	06/2008	Delayed due to amendment of scope. Revised dat:12/2010
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	R300,000	10/2007	Completed

Besides the above emission reduction projects the following monitoring and decision support projects have also been completed or if not, will be soon conducted (Table 32). These projects will provide the required information to update the 2006 baseline data.

Table 32: Monitoring and decision support projects Financial Year 2008

Project title	Project description	Project cost	Implementation target date	Status
PM_{10} monitoring	Continuous ambient air PM_{10} monitoring on site and in downwind communities, including meteorological data	R1,500,000	08/2008	Completed
PM_{10} source identification	Short term ambient air PM_{10} monitoring project to assist in emission source identification	R100,000	02/2008	Completed
Online stack monitoring	Continuous online point source emission monitoring phase 1 (Particulate Matter / TSP).	R6,000,000	06/2008	Delayed due to cost overrun. Revised date: 06/2009
APPA permit review	Extensive data collection of all point, fugitive, area and line sources of relevant pollutants during APPA permit review	R500,000	10/2007	Completed
AQMP and ERS development	Air Quality Management Plan and Emission Reduction Strategy development and facilitation	R100,000	01/2008	Completed
Emission Inventory update	Comprehensive Emission Inventory update based on data collected during APPA permit review;	R100,000	02/2008	Completed Amended 08/2008
Dispersion modelling	Dispersion modelling of current baseline	R100,000	03/2008	Completed Amended 08/2008

Metalloys provided DEAT with a comprehensive emissions reduction strategy including emission reduction and plots indicting the simulated concentration reductions. A number of options have been investigated, with some mutually exclusive and the most feasible and viable strategies will be investigated further for implementation. Metalloys will however ensure that the selected strategies conform to the requirements of the VTAPA AQMP. Some of the strategies in the ERS which have quantifiable emission reduction figures in Table 33. An additional 15 projects have been identified and included in the ERS process. However for these projects the emission reduction could not easily be quantified and was therefore not included even though some of these have already been implemented i.e. extensive greening of previous open areas.

An action plan for Metalloys is provided in Appendix B, Table 53.

Table 33: Emission Reduction Strategies investigated by Metalloys

	Project title	Project description	Emission reduction (%)	Impact reduction (%)(a)
West Plant	West Plant M12 Furnace Fugitives	Metal casting bay – installation f secondary fume extraction over the casting beds similar to secondary fume extraction at OBC charging	50%	50%
	West Plant	Raw material loading – installation of local dust e citation at all transfer points of raw materials (silo to pan, to scale, to belt feeders, to mixing bin through conveyor belts)	99%	99%
	West Plant OBC fugitives	Metal casting bed – installation of casting machine with localised section points at all transfer points	50%	50%
	West plant M12 Furnace fugitives	Enclose the current building of West Plant down to ground level with suction installed in the rood to capture all secondary fumes and dust generated in the process	30%	58%
South Plant	South Plant Furnace fugitives	Western side – extend roof over the crane bay/slag casting area, enclose side of furnace building, install extraction point on the roof over the crane bay to capture fugitive emissions Eastern side – lower the "veranda" on the casting side, enclose opposite sides of the building to prevent through draft, install extraction point at roof over this area to capture fugitive emissions	16%	49%
	South Plant bunkers	Enclose building, 2/3 extraction points installed in roof, with extraction hood linked to a baghouse.	99%	100%
	Paving of existing dirt roads	Eastern and western side of furnace building to be paved. Western side to minimise dust form casting bays	80%	80%
	Closing the furnace	Furnaces will b enclosed and the waste gas scrubbed and directed to Elgen	89%	95%
North Plant	Additional Secondary pollution plant	Additional secondary baghouse to be installed with dedicated hoods at slag tapping launders and casting area, casting machine, cast metal cooling bays and metal tapping launders. Smoke hood stacks and doghouse	70%	51%
	Dog-housing the entire plant	Closing the casting are to the south – there will be dedicated hoods for high fume are and an extraction system to handle the emissions from the top of the building. With emissions sent to the additional secondary bag-house		
	Product transporting conveyor to primary crusher	Installation of a conveyor/moving grate system to transport the product from end of the casting machine to the primary crusher, removing the use of FEL in the cooling bays	100%	100%
Materials Management Department	Road treatment	Dust-a-Side of fine untreated roads at the truck load-out station	90%	90%
	Upgrade of dust handling at final products	Upgrade of extraction system suction at primary crusher and improvement of dust handling at secondary dust extraction system (conveyor transfer points)	98%	97%
	New fogging systems	Installation of new water fogging system at road dispatch unit, rail loading and unit hopper	50%	26%
	Pelletising product handling system upgrade	Upgrade o pelletising raw materials system to feed directly to plants via CV18	100%	100%
	Rail tipper upgrade	Upgrade of rail tipper enclosure – additional fogging system	95%	95%
	Chemical dust suppression	Optimisation of chemical dust suppression system at the raw materials yard	88%	85%
	Conveyor transfer points	Installation of additional suppression at conveyor transfer points	51%	51%
	Raw material screen house	New dust extraction system at screen house	99%	99%

Notes: (a) Based on predicted annual average ground level concentrations at plant boundary

5.3.3.3 Davsteel (CapeGate) Emission Reduction Strategy

Davsteel was not flagged as one of the industries required to reduce their emissions since it was not a main contributor to the ambient concentrations. However, similar to ArcelorMittal Vereeniging, the potential exists for impacts on the immediate surrounding environment. Davsteel is however a Listed Activity and also falls under the APPA RC Review process. Minimum national emission limits will therefore apply to Davsteel which will require improvements (if not already implemented).

5.3.3.4 Additional Emission Reduction Interventions

Aside from the emission reduction strategies and interventions provided by the individual industries, recommended interventions from the government sectors that are applicable to the Iron and Steel are provided in Table 34.

Table 34: Emission reduction interventions for the Iron and Steel/Ferroalloys Industry.

Intervention	Responsible Party	Timeframe	Progress
Proper complaint handling system at the District Municipalities. This should include automatic complaint logging and a system to indicate whether the complaints was attended and resolved and by whom.	SDM, GP, DEAT	Short term (2009)	DEAT - Using FAQ & SAAQIS. SAAQIS in process of development - to include an air complaints section & complaints to be directed to relevant AQOs at Metropolitan or DM . SDM – system to be developed & implemented by the AQM Sub Directorate. LMs to expand on the existing logging system. FDDM – R150,000 available for developing an electronic complaints register at DM level
Development of government/community/industry liaison committees.	SDM, GP, DEAT	Short term (2009)	DEAT – use the existing MSRG/AQOF as established during the VTAPA AQMP project. SDM – AQM to coordinate. Ward based meetings to be extended in all LMs
Listed activities and related emission standards must be published.	DEAT	Short term (March 2009)	DEAT – the draft minimum emission standards are finalised and submitted to SABS for further technical assessment. The standards will be finalised by January 2009 and gazetted for public comment by March 2009. The emissions standards, including emissions monitoring and reporting requirements will come into effect 11 September 2009.
Emission monitoring, as specified in the National Framework	DEAT	Short term (September 2009)	DEAT - Emissions monitoring and reporting requirements to be gazetted as part of Section 21 notice.
Review of current APPA	DEAT (APPA RC	Short term	DEAT – determine emission limits based

Intervention	Responsible Party	Timeframe	Progress
Registration Certificates and conforming into new revised RCs and eventually AELs	Review project)	(2009)	on Section 21
Regulations on fee calculator to be used in calculating the prescribed processing fee for atmospheric emission licences	DEAT (APPA RC Review project)	Short term (2009)	DEAT – regulations will be drafted as soon as the fee calculator has been completed
Companies Social Responsibility programme	AMSA, Metalloys and Davsteel	Short term (2009)	
Enforcement and compliance – Green Scorpions	DEAT	Short term (2010)	
Development of the atmospheric user charge concept	DEAT	Short – Medium term (2012)	The user charge concept is a future project - will be initiated after license fee calculator project (part of APPA RC Review)
Implement priority area emissions trading system i.e. fund other projects other than own, that will result in a decline in emissions	DEAT	Short – Medium term (2012)	Industries to submit proposal to DEAT

Notes:
SDM – Sedibeng District Municipality
COJ – City of Johannesburg Metropolitan Municipality
DEAT – Department of Environmental Affairs and Tourism
AMSA – ArcelorMittal South Africa
FDDM – Fezile Dabi District Municipality
GP – Gauteng Province
FSP – Free State Province
LM – Local Municipality

5.3.4 Mining Industry

There are three large mining operations within the VTAPA namely:

- New Vaal Colliery (Anglo Coal) - Vereeniging
- Sigma Colliery (Sasol) – Sasolburg
- Glen Douglas Dolomite Quarry - Meyerton

Of the three mines, only New Vaal Colliery provided an emission reduction strategy including mitigation measures currently and planned to b employed at their operations.

5.3.4.1 Proposed New Vaal Colliery Emission Reduction Commitments

As outlined in their Environmental Management Programme Report (EMPR) in 2006, New Vaal Colliery has initiated various interventions to address air quality related concerns due to activities at their plant. Such interventions are included in Table 35 with Table 54 (in Appendix B) reflecting the intervention action plan.

Table 35: Emission reduction projects for New Vaal Colliery

Project title	Project description	Status	Target Date
Operation of a dust fallout monitoring programme	32 single and 9 directional dust bucket monitoring network	Ongoing	Short Term (2008)
An air emissions inventory	Has been developed for the mine but need to be updated to reflect the current operational status.	Ongoing	Short Term (2008)
Implementation of dust suppression technologies	- 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	Ongoing	Short Term (2008)
Dust-a-side application on haul roads	Current 8km; total planned 13.8km		Short Term (End 2008)
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		Short Term (End 2008)
Dust hood installed at secondary crushers	Motor damper arrangement to be finalized		Short Term (End 2008)
Buffer blasting programme	Implementation of buffer blasting programme to minimise ingress of air into old workings	ongoing standard operating procedure	Short Term (2008)
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 levels	ongoing standard operating procedure	Short Term (2008)
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		Short Term (end July 2008)

5.3.4.2 General Emission Reduction Interventions

Emission reduction interventions for the mining industry in general are shown in Table 36.

Table 36: Emission reduction interventions for the Mining Industry.

Intervention	Responsible Party	Timeframe	Progress
Detailed emission reduction strategies to ensure compliance with ambient air quality standards to be submitted to DEAT	New Vaal, Sigma, Glen Douglas (Sasol to provide current status of all Sigma activities during closure phase as well as stock piles and conveyors dust emissions monitoring results)	Short Term (2008/9)	DME to ensure local authorities are represented in the inter-departmental committee FDDM – member of Regional Mining Development & Environmental Committee, Minerals & Energy Free State SDM – AQM sub directorate to coordinate
Representation of local authorities on the inter-departmental committee tasked with the regulation of mining activities	SDM, GP, DEAT & DME	Short Term (2008/9)	SDM – LMs to form liaison committees with the local mines
Investigate to ensure all mining operations within the VTAPA has approved EMPRs (specifically smaller mining and quarry operations)	SDM & FDDM together with DME	Short Term (2008/9)	FDDM – target 12/2008 SDM – AQM sub directorate to coordinate. LMs to monitor mining activities.
Identify all smaller mining and quarry operations not included into the and obtain emissions information from these to be included into the VTAPA Emissions Inventory	SDM & FDDM together with DME	Short Term (2008/9)	FDDM – target 12/2008 SDM – LMs to conduct a survey and capture all data
Development of the atmospheric user charge concept	DEAT	Short Term (2008/9)	
Annual roadworthy checks for all mine export vehicles	SDM, GP	Short – Medium Term (2012)	SDM – AQM sub directorate to coordinate
Encouragement of the planting of trees	SDM, FDDM, GP, FSP	Short – Medium Term (2012)	FDDM – ongoing SDM – AQM sub directorate to coordinate & collaborate with LMs. LMs to promote clean & green programmes
Regular internal and external audits to be conducted (external by independent party) and reported to the District Municipality	SDM, FDDM, GP, FSP		FDDM – request from DME SDM – AQM sub directorate to coordinate. LMs to regularly liaise with affected stakeholders

Notes:
SDM – Sedibeng District Municipality
COJ – City of Johannesburg Metropolitan Municipality
DEAT – Department of Environmental Affairs and Tourism
LM – Local Municipality
FDDM – Fezile Dabi District Municipality
GP – Gauteng Province
FSP – Free State Province

5.3.5 Petrochemical Industry

The petrochemical industries that were identified as the main contributing sources to ambient air quality within the VTAPA were Sasol and Natref, both located near Sasolburg. Omnia, which is also located near Sasolburg, was also identified as a contributing source.

Sasol is required to reduce ambient concentrations of NO_2 by ~18% and SO_2 concentrations by ~7%. Natref needs to reduce SO_2 concentrations by between 1% and 5% whereas Omnia is required to reduce PM_{10} concentrations by ~2.5%.

5.3.5.1 SASOL Emission Reduction Commitments

Sasol, Sasolburg continuously strives towards implementing cleaner technologies as a way of reducing its environmental impact of its chemical processes. As a result, the Sasolburg operations converted from a predominantly coal based feedstock to a natural gas feedstock and through this conversion have realised improvements in their emissions to atmosphere, water and land (Waste). This was done prior to the declaration of the Vaal Triangle as a priority area. The present boilers operated as part of the steam and power generation systems have also been optimised and are operated at emission concentrations much lower than the current allowable emission limits.

In addition, Sasol operates five ambient monitoring stations in the Sasol area since 1990. Sasol has also been involved in the active roll-out of some 10,000 households of the Basa Njengo Magogo fire making method in Zamdela.

Sasol Infrachem, a division of Sasol Chemicals Industries (Pty) Ltd, has identified 3 main SO_2 sources from its operations in Sasolburg. A statement indicated that the smallest of the three sources will be reduced by 10% but that this will not meet the overall required reduction of 7%. Sasol will increase SO_2 and NO_x emissions over the short-term by re-commissioning the old boilers for electricity generation. Particulate emissions will be removed by optimising the current ESPs but SO_2 and NO_x will not be controlled resulting in an overall increase in PM_{10}, SO_2 and NO_x emissions. Sasol will off-set these increases in emissions by implementing further Basa Njengo Magogo fire making methods in Zamdela and surrounding areas.

The Sasol action plan is included in Appendix B (Table 55) with the main discussion points included in Table 37.

Table 37: Sasol's reduction plan

Project title	Project description	Improvement	Target Date
Smallest of the three sources	The smallest of the three sources will be reduced by 10%	Total emission reduction not known	Short term (June 2009)
Reduction of the two larger sources, the steam producing facilities	There are three options, namely: 1. Retrofit a number of boilers on both steam station units as to reduce SO_2 and NO_x emissions. This will result in SO_2 and NO_x compliance within 7 – 10 years. 2. Some of the steam station equipment is more than 55 years old and nearing the end of its useful lifetime. Thus, the option is to decommission the oldest equipment and rebuild it on a modular approach. This will result in a significant reduction in emissions but will take 6-8 years. 3. Build a new unit replacing the existing two steam stations. This will result in a significant reduction in emissions but will take 10 – 20 years.	Sasol will investigate the best option – no emission reduction in the short-medium term	Initiate July 2008 Long term (2012-2017)
Increasing in capacity	Sasol will only be allowed to re-commission old boilers subject to the following conditions: o Sasol must adhere to the requirements of any other applicable environmental legislation o The emission standards of the boilers must comply with national minimum emission standards for existing plants o The boilers will only be allowed to operate for a period of 10 years from date of promulgation of this plan o Within 5 years of the date of promulgation, Sasol must indicate their preffered emission reduction strategy with regards to the boiler emissions	Increase in PM_{10}, SO_2 and NO_x emissions	End 2008
Emission off-setting	Due to Sasol's planned increases in emissions (due to the restart of the boilers), it will offset its emissions by implementing further Basa Njengo Magogo fire making methods in Zamdela and surrounding areas.	ongoing	Short term (2008/9)

5.3.5.2 NATREF Emission Reduction Commitments

The National Petroleum Refiners of South Africa (NATREF) have an approved Environmental improvement plan mutually agreed with DEAT and NGO's in 2002. The refinery currently awaits legislation to be promulgated about further improvements in fuel specifications and therefore does not have a mandate to include long range improvement projections. However, the refinery remains committed to fulfil its commitments towards the improvement plan by 2009 agreed upon in 2000. The improvements agreed upon as well as projections towards 2009 and ***indicative*** 2015 improvements are reflected in Table 38. The associated action plan for Natref is provided in Appendix B, Table 56.

In order to comply with the intended improvements, the routine operational monitoring associated with point source management as well as routine ambient air quality monitoring station information interpretation (operated by Sasol) will continue.

Table 38: NATREF emission reductions since 2000.

	Capital invested Rm	2000	2006	2009	% improvement
Refinery static (point) source emissions					
Sulphur dioxide t/d	126.9	65	38		41
Nitrogen oxide t/d	3.0	3.5	2.9		17
Volatile organics t/d	10.9	4.55	3.08		33
Post 2006 improvements					
Sulphur dioxide t/d	25[2]			32	16
Nitrogen oxide t/d				2.65	9
Volatile organics t/d	34.1[2]			3.05	1
Mobile source emissions (vehicles)					
Sulphur dioxide[1] t/d	543	18.75	1.75		>80
Nitrogen oxide t/d					
Volatile organics t/d					
Post 2015 improvements (subject to DME/DEAT regulations)					
Sulphur dioxide[1] t/d	>5 000			0.20	>80
Nitrogen oxide t/d					
Volatile organics t/d					

Note 1 Not adjusted for increased product volumes
Note 2 Operating cost and or renewal maintenance

5.3.5.3 OMNIA Fertiliser Emission Reduction Commitments

In order to comply with the relevant environmental legislation for air pollution control, Omnia has installed emissions monitoring and control systems at its various production units at the Sasolburg site and is also investigating others. Air emission reduction systems have also been installed and optimisation plans to improve their effectiveness are currently underway.

In order to comply with the stricter ambient air quality requirements for the VTAPA, Omnia will optimise the existing emissions monitoring, control and reduction strategies. In addition, Omnia will investigate and commission new emission reduction strategies as depicted in Table 39 (see Appendix B, Table 57 for the implementation action plan).

Going forward, Omnia will use the online data from the various stack analysers, ambient air monitoring station and the dispersion model to complete a baseline database. The baseline data will be used to design, review, optimise and evaluate different emission reduction strategies and to benchmark with other fertiliser production facilities globally. This exercise will be important for providing a correct design basis to ensure that implemented solutions will be sustainable and will result in the improvement of ambient air quality in the VTAPA as set out in the AQMP. The chosen strategies or technology must have minimal negative environmental impact as possible.

In conclusion, Omnia will complete the baseline database within the short term. During this period, the current projects will also be completed as detailed above. Also, the different available air emission reduction strategies and control strategies will be evaluated using the baseline database as the design basis. At the end of this period, a suitable strategy or strategies will be chosen and this will be implemented and commissioned within the medium to long term. The primary objective is to implement air emissions reduction strategies and to improve the ambient air quality as soon as feasible, taking into account all possible constraints and impacts. Omnia Fertilizer Sasolburg is committed to sustainable development and will implement required actions in a responsible manner in order to fulfil this objective.

Table 39: Air emission reduction strategy for Omnia

Project title	Project description	Target Date
Online stack monitoring	Installation of online stack monitoring equipment at the nitric acid plant. Installation of online monitoring equipment at the granulation plant to improve measurement and management of dust emissions	Short term (2008/9)
NO_x abatement	Committed to reduce NO_x emissions by at least 80% from the 2007 emissions load through the installation of appropriate abatement technology.	Short term (2008/9)
Improving ambient air quality	Reducing fugitive dust emissions in certain areas of the granulation plants through the systematic implementation of improved practices.	Short term (2008/9)
Reduction of fluoride emissions	Reduction of fluoride emissions through the installation of improved scrubbing technology at the Superphosphate plant	Short term (2008/9)
Further reduction of fugitive dust	Roll out improvement practices to other areas within the granulation plants to further reduce dust emissions	Medium – Long term (2009-12)
Emissions reduction technologies and air quality management practices	Evaluate Granulation Plant 2 stack emissions and investigate best practical environmental option Evaluate best practical environmental options for material loading and offloading activities	Medium – Long term (2009-12)
Awareness raising	Improve awareness amongst employees and communities through targeted initiatives and awareness campaigns	Medium – Long term (2009-12)

5.3.5.4 Additional Emission Reduction Interventions

The interventions for the Petrochemical and Fertiliser industries are provided in Table 40.

Table 40: Emission reduction Interventions for the Petrochemical Industry.

Intervention	Responsible Party	Timeframe	Progress
Proper complaint handling system at the District Municipalities. This should include automatic complaint logging and a system to indicate whether the complaints was attended and resolved and by whom.	SDM, GP, DEAT	Short term (2009)	DEAT - use FAQ & SAAQIS. SAAQIS in process of development - to include an air complaints section & complaints to be directed to relevant AQOs at Metropolitan or DM. SDM – system to be developed & implemented by the AQM Sub Directorate FDDM – R150,000 available for developing an electronic complaints register at DM level
Development of government/community/industry liaison committees using the existing MSRG/AQOF as established during the VTAPA AQMP project	SDM, GP, DEAT	Short term (2009)	DEAT – use the existing MSRG/AQOF as established during the VTAPA AQMP project SDM – AQM sub directorate to coordinate. FDDM – Sasolburg Community Working Group
Listed activities and related emission	DEAT	Short term	DEAT - The standards will be

Intervention	Responsible Party	Timeframe	Progress
standards must be published.		(March 2009)	finalised by January 2009 and gazetted for public comment by March 2009.
Emission monitoring, as specified in the National Framework	DEAT	Short term (September 2009)	DEAT - Emissions monitoring and reporting requirements to be gazetted as part of Section 21 notice
Review of current APPA Registration Certificates and conforming into new revised RCs and eventually AELs	DEAT (APPA RC Review project)	Short term (2009)	DEAT – determine emission limits based on Section 21
Regulations on fee calculator to be used in calculating the prescribed processing fee for atmospheric emission licences	DEAT (APPA RC Review project)	Short term (2009)	DEAT – regulations will be drafted as soon as the fee calculator has been completed
Companies Social Responsibility programme	Sasol, Natref & Omnia	Short term (2009)	
Enforcement and compliance – Green Scorpions	DEAT	Short term (2008/9)	
Investigating the funding of Basa Njengo Magogo rollout in Zamdela by Sasol, Natref and Omnia	FDDM, FSP & DEAT	Short term (2009)	DEAT – pert of Clean Fires Campaign SDM – advising BnM project s o industries and educate community to understand health benefits FDDM – Sasol already funding
Development of the atmospheric user charge concept	DEAT	Short – Medium term (2012)	
Sasol's re-commission of old boilers should be negotiated with the licensing authority to ensure commitments for long term improvements.	Licensing authority, Sasol	Short – Medium term (2012)	DEAT / Licensing authority – as part of conditions in the APPA Registration Certificate / Atmospheric Emission License
Implement priority area emissions trading system i.e. fund other projects other than own, that will result in a decline in emissions	DEAT	Short – Medium term (2012)	Industries to submit proposal to DEAT
Measure for VOCs, PM_{10}, $PM_{2.5}$, O_3 (Consider secondary pollutants)	DEAT	Short – Medium term (2012)	DEAT – all pollutants currently being measured as part of ambient monitoring network
More stringent fuel specification could result in more production of emissions (SO_2, NO_2 and CO).	DME and DEAT	Short – Medium term (2012)	DEAT - This is dependent on vehicle emission standards to be proposed by DEAT DME to tighten the specifications
Comply beyond ambient standards to allow for i) further expansion, ii) upset conditions and iii) failures in reduction strategies	DEAT (National Framework)	Short – Medium term (2012)	DEAT – depends on National Framework review
Encouragement of planting of trees	FDDM & FSP	Short – Medium term (2012)	SDM – AQM sub directorate to coordinate & collaborate with local municipalities. LMs to encourage clean & green programmes FDDM – ongoing
Notes:		FDDM – Fezile Dabi District Municipality	

Intervention	Responsible Party	Timeframe	Progress
SDM – Sedibeng District Municipality		GP – Gauteng Province	
COJ – City of Johannesburg Metropolitan Municipality		FSP – Free State Province	
DEAT – Department of Environmental Affairs and Tourism		LM – Local Municipality	

5.3.6 Power Generation Industry

Lethabo Power Station is the only coal fired power station located within the Vaal Triangle Airshed Priority Area. Lethabo Power Station a major point source of SO_2 emissions. According to the baseline assessment Lethabo need to reduce ambient concentrations of SO_2 by up to ~58%.

5.3.6.1 Eskom Emission Reduction Commitments

An air quality management plan has been compiled by Eskom for Lethabo Power Station in response to the declaration of the Vaal Triangle as a National Priority Area for air quality management. The implementation action plan is provided in Appendix B (Table 58) with a summary of the main interventions included in this section (Table 41).

Air quality management practices currently applied at Lethabo Power Station include ash handling management practices, dust suppression at the coal stockyard and management of stack particulate emissions.

- Lethabo has the biggest ash dump of all Eskom's power stations, producing more than 21,000 tonnes of ash per day. Currently the ash dump is controlled through irrigation and management of the active face and rehabilitation. The active face is irrigated with effluent water from the power production process, covering an area of approximately 2.5 km by 40 m. The ash dump is also continuously rehabilitated by means of five different types of grass.
- The coal stockyard is managed by New Vaal Colliery with specific mitigation measures described in Section 5.3.4.1, Table 35.
- Particulate emissions from the stack are removed from the flue gas stream by means of an electrostatic precipitator (ESP). Lethabo's emissions were reduced by over 60% between 2001 and 2004 mainly due to the installation of a flue gas conditioning (an SO_3) plant. The SO_3 plant improves the efficiency of the ESP by injecting trace amounts of SO_3 into the flue gas which reduces resistivity of the ash and so enhances the ability of the ESP to charge and therefore remove it.

Several additional particulate reduction projects have been completed or are planned for Lethabo. These are described in Table 41. Overall, the particulate emissions at Lethabo have been reduced despite increases in the amount of coal used per annum.

Table 41: Emission reduction projects at Lethabo Power Station.

Project title	Project description	Target Date
ESP transformer upgrade	As the transformers fail, they will be replaced. There is a current stock of six upgraded spares. This will ensure or increase the reliability and availability of the ESP fields.	Ongoing
Installation of the ESP Plant management System	This will optimise the operation of the ESPs to reduce emissions and allow better management of the rapping procedure.	Completed
SO_3 distribution lance upgrade	This is to prevent the blockage of the nozzles in order to ensure proper distribution of SO_3, and will thus improve the efficiency of the ESP	Completed
Replacement of the MCS1 with MCS2	To allow better control of the ESP fields, and ensure that spares are available	Completed

Project title	Project description	Target Date
Installation of the load cells in Unit 5	Load cells have been installed. Rapping optimisation is in progress.	In progress – Short term (2008)
Replacement of the secondary air heater element packs	Unit 1 is outstanding in the current maintenance cycle. This will be conducted every six years until the end of station life.	Short term (December 2008)
On-line stack monitoring	Continuous emissions monitoring system to measure SO_2, NO_x, CO and O_2 in the flue gas will be installed in Unit 1. This will allow compliance monitoring with the conditions in the emissions license.	Short term (March 2009)
	Continuous emissions monitoring systems will be installed on all units	Medium term (2014)
Ambient monitoring station	An ambient monitoring station measuring SO_2, NO_2, and PM_{10} will be established at Refengkgotso ~ 20km southeast of Lethabo. Air Quality reports detailing the findings of the monitoring at the Refengkgotso monitoring station will be compiled on a quarterly basis and submitted to DEAT.	Short term (March 2009)
Fugitive emissions monitoring network	A network will be established to monitor fugitive emissions (PM_{10}) from the ash dump at Lethabo. It will initially include two monitoring stations and will be expanded if needed.	Short term (March 2009)
Communication channel for upset conditions	Complaints about emissions from Lethabo are received and addressed by the environmental practitioners at the station. This is primarily regarding start-ups and upset conditions. Notification of upsets is send to DEAT, SDM, Metsimaholo Municipality, Sasol Infrachem and Three Rivers community representative.	In place and Ongoing Short term (2008)
SO_2 emission reduction	The investigation into retrofitting the power station with FGD as done by Eskom showed that such an action is not feasible or economically viable. An investigation is currently underway to assess the feasibility of coal beneficiation with respect to sulphur removal. If this is feasible, steps will be taken to implement it.	Short term (June 2009)
Energy efficiency measures	Extend energy supplies and reducing greenhouse gas emissions. Eskom's "billion kilowatt-hour" savings project focuses on internal initiatives to reduce energy consumption. Lethabo initiated a lighting programme to further improve energy efficiency at the power station, resulting in a saving of 735 MWh a year.	In place and Ongoing Short term (2008)
Offset projects	Eskom was involved in the "Winter of 2008 Clean Fires Campaign" together with Sasol on the Basa Njengo Magogo activities in the Vaal Triangle Area. Eskom is also using the Eskom Energy and Sustainability Programme for education and awareness creation.	Not specified
Offset projects	Electrification programme – Eskom's electrification projects scheduled for the Vaal Triangle include Emfuleni (Tshepiso N ext 1 – 295 households), COJ (Nomzamo – 470 households).	Short term (2008/2009)

5.3.6.2 Additional Emission Reduction Interventions

The listed activities and emission standard setting project will influence how emissions from this group are controlled in the future. Minimum emission limits will be established for identified listed activities, which include the power generation industry. In terms of the requirements of AQA, listed activities will be required to undertake emissions monitoring. Continuous, on-line stack monitoring will be required in areas that are not in compliance with ambient air quality standards, especially within declared priority areas. Eskom has undertaken to install a continuous monitoring system on one unit of Lethabo power station by March 2009, and to install continuous emission monitoring systems on all units of the power station by 2014.

Recommended interventions to address emissions from the power generation industry in the VTAPA are outlined in Table 42.

Table 42: Emission reduction interventions for the power generation industry.

Intervention	Responsible Party	Timeframe	Progress
Proper complaint handling system at the District Municipalities. This should include automatic complaint logging and a system to indicate whether the complaints was attended and resolved and by whom.	SDM, GP, DEAT	Short term (2009)	DEAT - using FAQ & SAAQIS. SAAQIS in process of development - to include an air complaints section & complaints to be directed to relevant AQOs at Metropolitan or DM. SDM – system to be developed & implemented by the AQM Sub Directorate SDM – continuous data capturing and logging system FDDM – R150,000 available for developing an electronic complaints register at DM level
Development of government/community/industry liaison committees using the existing MSRG/AQOF as established during the VTAPA AQMP project	SDM, GP, DEAT	Short term (2009)	DEAT – use the existing MSRG/AQOF as established during the VTAPA AQMP project SDM – system to be developed & implemented by the AQM Sub Directorate. LMs to liaise with industry & community FDDM – Sasolburg Community Working Group
Listed activities and related emission standards must be published.	DEAT	Short term (March 2009)	DEAT - The standards will be finalised by January 2009 and gazetted for public comment by March 2009.
Emission monitoring, as specified in the National Framework	DEAT	Short term (September 2009)	DEAT - Emissions monitoring and reporting requirements to be gazetted as part of Section 21 notice
Review of current APPA Registration Certificates and conforming into new revised RCs and eventually AELs	DEAT (APPA RC Review project)	Short term (2009)	DEAT – determine emission limits based on Section 21
Regulations on fee calculator to be used in calculating the prescribed processing fee for atmospheric emission licences	DEAT (APPA RC Review project)	Short term (2009)	DEAT – regulations will be drafted as soon as the fee calculator has been completed
Companies Social Responsibility programme	AMSA, Metalloys and Davsteel	Short term (2009)	
Enforcement and compliance – Green Scorpions	DEAT	Short term (2008/9)	
South African Mercury Assessment	DEAT	Short term (2009)	DEAT – international study on Mercury Assessment (SAMA) – data made available to AQOF/MSRG when finalised.
Use of billboards to raise awareness around the impact of good air quality management	DEAT, Eskom	Short term (2008)	DEAT - part of Clean Fires Campaign

Intervention	Responsible Party	Timeframe	Progress
Development of the atmospheric user charge concept	DEAT	Short – Medium term (2012)	
Investigate the feasibility of solar energy and why it is not advanced in South Africa. Eskom has experience in the form of the Shell Renewable–Eskom joint venture conducted in 1999.	DEAT & DME & Eskom	Short – Medium term (2012)	
Electrification of low cost houses (Included in Eskom's interventions)	DEAT & DME & Eskom	Short - Medium term (2008 – 2012)	
Stricter regulations to be enforced for start up emissions/cleaner technologies	DME	Short – Medium term (2012)	DME to develop these regulations
Restriction of export of high quality coal	DME	Short – Medium term (2012)	DME to develop these regulations
No new power stations to be allowed in the stressed area until such time as the ambient concentrations are within compliance with the VTAPA AQ Targets	DEAT	Short – Medium term (2012)	DEAT – use EIA regulations (Chief Directorate: Environmental Impact Management)

Notes:
SDM – Sedibeng District Municipality
COJ – City of Johannesburg Metropolitan Municipality
DEAT – Department of Environmental Affairs and Tourism
LM – Local Municipality
FDDM – Fezile Dabi District Municipality
GP – Gauteng Province
FSP – Free State Province

5.3.7 Small Industries

5.3.7.1 Proposed Emission Reduction Interventions

Limited information is available on small industries within the Vaal Triangle Airshed Priority Area. Emfuleni Local Municipality is the only Municipality to have an existing database of fuel burning appliances within the Municipality. The City of Johannesburg is currently in the process of identifying all boilers and incinerators within the City. It is essential that an electronic database of all small industries is developed by each Municipality and this should regularly be updated on an annual basis. This information should then be forwarded to the respective District Municipality and National Government. This database should, at a minimum, include information on:

- Company name and contact details,
- Type of fuel burning appliance (e.g. boiler, incinerator, furnace),
- Type of fuel,
- Quantity of fuel used,
- Stack parameters (height, diameter, gas exit temperature and gas exit velocity),
- Sulphur and ash content of fuel (where applicable),
- Periods of operation,
- Control equipment (e.g. grit collectors).

In terms of AQA, fuel burning appliances can be declared as controlled emitters if it results in atmospheric emissions which prevent a threat to human health and the environment. It has been recommended that fuel burning appliances be declared as controlled emitters in the region to effectively regulate this group of sources. Other proposed emission reduction interventions for small industries are shown in Table 43. A generic action plan for the highlighted interventions is provided in Table 59 of Appendix B.

Table 43: Emission reduction interventions for Small Industries.

Intervention	Responsible Party	Timeframe	Progress
Electronic database of all small industries to be compiled by Municipalities	SDM, FDDM, COJ	Short Term (2008)	SDM – function to be undertaken by LMs. Midvaal LM in the process of developing a database of industries in the Midvaal Region. DM to compile into one database FDDM – target 12/2008
Develop a permit system for all non-listed activities	DEAT	Short Term (2008)	
Company orientated community initiatives	SDM, FDDM, COJ	Short – medium Term (2012)	SDM – LMs to liaise with companies FDDM – to engage small industries, focus has been on large industries
Model scheduled trade by-laws	SDM, FDDM, COJ	Short – medium Term (2012)	SDM – coordinate development of by-laws FDDM – air quality by-laws to be drafted in 2009/2010
Small boilers to be declared as controlled emitters.	DEAT	Medium – Long Term	DEAT - There is a proposal on the requirements for small boilers in the current standard setting process. Expected to be gazetted by the end of the year.

Notes:
SDM – Sedibeng District Municipality
COJ – City of Johannesburg Metropolitan Municipality
DEAT – Department of Environmental Affairs and Tourism
LM – Local Municipality
FDDM – Fezile Dabi District Municipality
GP – Gauteng Province
FSP – Free State Province

5.3.8 Transportation

5.3.8.1 National Government Interventions

Provision is made in the Atmospheric Pollution Prevention Act (APPA) No.45 of 1965 for the control of air pollution by fume emitted by vehicles. Regulations concerning the control of noxious or offensive gases emitted by diesel driven vehicles were published in the government gazette on the 20th of September 1974. These regulations prescribed the procedure, known as the free acceleration test, of performing an opacity test using a BP-Hartridge meter.

In 2003, DEAT, in collaboration with DME, developed the *Joint Implementation Strategy for the Control of Exhaust Emissions from Road-going Vehicles in South Africa*. Measures to reduce vehicle emissions in urban areas include:

- Introduction of Euro vehicle emission regulations in petrol-driven vehicles,
- Introduction of ECE standards for diesel-driven vehicles,
- Reduction in the maximum sulphur content of unleaded petrol to 500 ppm from 2004 and to 50 ppm from 2010,
- A maximum benzene content in petrol of 3% from 2006 and 1% from 2010,
- A maximum aromatic content in petrol of 42% from 2006,
- Prohibition of lead based additives to petrol from 2006,
- Reduction in the maximum sulphur content of diesel to 500 ppm from 2006 and 50 ppm from 2010.

The Air Quality Act, No 39 of 2004 makes provision for the Minister or Provincial MECs to declare vehicles or vehicles falling within a specified category as a 'controlled emitter'. Emission standards, which include standards setting the permissible amount, volume, emission rate or concentration of a specified substance or a mixture of substances needs to be established for such emitters. Measurements of emissions from controlled emitters must also be carried out. The Act also makes provision for the declaration of a substance or a mixture of substances as a 'controlled fuel'. Standards may be established for the use, manufacture, sale and composition of the controlled fuel. Alternatively the manufacture, sale or use of the controlled fuel could be prohibited.

5.3.8.2 Local Government Interventions

The City of Johannesburg has outlined various interventions to address emissions from vehicles within the City.

These proposed short-term interventions to address emissions from vehicles include the:

- Training and designation of Air Quality Officials as Environmental Management Inspectors,
- Establish a comprehensive vehicle emissions monitoring and diesel vehicle testing sampling plan,
- Drafting and implementation of local by-laws to facilitate the testing of diesel, turbo diesel and petrol vehicles as well as the enforcement of emission standards developed as part of the National Vehicle Emission Standards,
- Creation of a forum that will have representatives from local, provincial and national government, the private sector, non-governmental organisations, government agencies and academic institutions. The Forum's objective is to formulate and implement the integrated vehicle emission reduction strategy and co-ordinate the existing efforts of several institutions,
- Quantification of vehicle emissions for all types of vehicles through on-board vehicle emission measurements and atmospheric dispersion modelling simulations,
- Identification of congested traffic intersections at which street box monitoring stations will be located to measure vehicle emissions,
- Development of an awareness program,
- Create partnerships with relevant parties such as big business and provincial government departments within the City in order to receive support on other initiatives such as flexi-time working hours in order to reduce peak hour traffic,
- Conduct on-board vehicle emission measurements of SO_2, NO_x and CO to develop emission factors and validate current emission factor models. The emission data collected will be used to characterise the actual on-road vehicle emissions. The result will indicate the effects of roadway design, traffic signal timing, traffic conditions and driving style/habits. This information will be used for transport planning and to inform the public on how to minimize pollution and contribute to a cleaner environment.

Medium term measures include the:

- Integration of cleaner technology requirements into the "Metro Bus" and City's Vehicle Fleet through liaison within the Johannesburg Transport and Air Quality Co-ordinating Committees,
- Development of benchmark standards for vehicle emissions based on International "Best Practice" Standards,
- Develop the City's State of Energy Report that will quantify the fuel type and consumption within the city. In addition to this, Environment Management will develop a Climate Change and Energy Strategy.

5.3.8.3 Proposed Emission Reduction Interventions

As with all sources, a comprehensive, detailed emissions inventory of vehicle emissions is required to accurately quantify the contribution of this source to the ambient air quality situation in the region. The current traffic count data obtained for the major roads in the region as part of the Baseline Assessment needs to be updated as and when this information becomes available. Other un-quantified sources include airports and railways as these are not considered to be significant sources. However, this information should be collated as it becomes available or when it becomes a significant contributing source.

Collaboration between all spheres of Government is required to ensure that vehicle emissions are effectively managed. National Government is responsible for the introduction of legislation and regulations to control vehicle emissions with their implementation undertaken at the Local Level. Interventions to address vehicle emissions need to be undertaken with the involvement of all Local and District Municipalities in the region. Also, the experience and knowledge gained by other Municipalities in the management of vehicle emissions, such as the City of Cape Town Metropolitan Municipality, should be shared and integrated. The City of Cape Town has implemented a successful programme of diesel vehicle testing within the City to address vehicle emissions. A possible partnership between the Local Authorities in the Vaal Triangle and the City of Cape Town would assist with a coordinated approach to vehicle emissions monitoring.

The cooperation between the different departments within each Municipality is also required for the effective implementation of any emission reduction measures. These interventions require the interaction of the transport, housing and planning departments and any other relevant departments to ensure that measures introduced are reflected in all departments.

Vehicles are likely to be declared the first controlled emitter in South Africa. The following phased approach for the implementation of vehicle emission standards has been recommended in the National Framework document:

Euro 1 emission standards for all homologated vehicles	-	January 2004
Euro 2 emission standards for all newly homologated vehicles	-	January 2006
Euro 2 emission standards for all newly manufactured vehicles	-	January 2008
Euro 4 emission standards for all newly homologated vehicles	-	January 2010
Euro 4 emission standards for all newly manufactured vehicles	-	January 2012

Other proposed interventions include the tarring or cementing of roads to reduce dust entrainment and the planting of trees which act as an effective dust barrier. Alternative transportation methods such as the rail network must be encouraged to reduce the use of private transportation.

Proposed emission reduction interventions to address emissions from the transportation sector are outlined in Table 44. Similar to the previous problem complexes, action plans are provided in Appendix B (Table 60) for the highlighted interventions.

Table 44: Emission reduction interventions for the transportation sector.

Intervention	Responsible Party	Timeframe	Progress
Synchronisation of traffic lights to promote the flow of traffic	SDM, FDDM, COJ	Short term (2009)	FDDM – to form partnerships with local & provincial traffic departments SDM – to engage & coordinate with LMs. LMs to coordinate with traffic departments
Taxi recapitalisation programme	DME	Short term (2009)	
Integrate all stakeholders in road construction and planning e.g. taxi associations	SDM, FDDM, COJ	Short term (2009)	SDM – to liaise with taxi associations during public meeting FDDM – to form transportation sector forum
Tarring or cementing roads	SDM, FDDM, COJ	Short term (2009)	SDM – ongoing LM projects FDDM – to form partnerships with local & provincial road networks
Encouragement of planting of trees	SDM, FDDM, GP, FSP	Short term (2009)	SDM – LMs to encourage cleaning & greening projects FDDM – ongoing
Vehicle emission blitz in partnership with the City of Cape Town	SDM, FDDM, COJ	Short term (2009)	SDM – to engage & coordinate with local municipalities FDDM – Hartridge meter to be procured in 2009/10
Review vehicle emissions database with updated traffic count data as these become available	SDM, FDDM, COJ	Short term (2008/9) - ongoing	SDM – to engage & coordinate with local municipalities. Database to be established FDDM –to form partnerships with local & provincial traffic departments
Roadworthy certification to ensure vehicles are maintained	SDM, FDDM, COJ	Short term (2008/9) - ongoing	SDM – to engage & coordinate with LMs & private service providers FDDM –to form partnerships with local & provincial traffic departments
Improved fuel quality (reduction of sulphur in petrol to 50 ppm) – bringing Department of Transport onboard	DME	Short- Medium term (2012)	
Legal stipulation of new technology for vehicles	DME	Short- Medium term (2012)	
Heavy trucks to use alternative routes and not pass through City and Towns	SDM, FDDM, COJ	Short- Medium term (2012)	SDM – too ambitious and not practical in SDM FDDM –to form partnerships with local & provincial traffic departments
Regulation of diesel driven vehicles	SDM, FDDM, COJ	Short- Medium term (2012)	DEAT – future emitters project, Norms and Standards Project. Regulations developed by national department will not affect the on-road vehicle fleet, thus Local authorities are expected, through by-laws to establish control measures

Intervention	Responsible Party	Timeframe	Progress
			for on-road vehicles
Vehicles to be declared controlled emitters. This will only effect new vehicles	DEAT	Short- Medium term (2012)	DEAT – future emitters project, Norms and Standards Project. Regulations will only affect new vehicles, not on-road fleet
Introduction of a vehicle monitoring programme	SDM, FDDM, COJ	Medium term (2012)	FDDM – Hartridge meter to be procured in 2009/10 SDM – to engage & coordinate with local municipalities
Transnet must be called to task to address the rail network and improve it as an alternative to road transportation	National (Department of Transport & Transnet)	Medium – Long term	Department of Transport should be lead agent
Update emissions inventory with airport and railway information as it becomes available or when it becomes a significant source	SDM, FDDM, COJ	Medium – Long term	FDDM – ongoing SDM – to coordinate
Notes: SDM – Sedibeng District Municipality COJ – City of Johannesburg Metropolitan Municipality DEAT – Department of Environmental Affairs and Tourism		FDDM – Fezile Dabi District Municipality GP – Gauteng Province FSP – Free State Province LM – Local Municipality	

5.3.9 Waste Burning

5.3.9.1 Proposed Emission Reduction Interventions

The quantification of emissions from waste burning in the VTAPA was not undertaken as part of the baseline assessment due to the variability in emissions from these sources as well as the availability of limited information in the region. As a first step to address waste burning in the region, a comprehensive emissions inventory of waste sources should be compiled. This should include information on landfill sites, incinerators, sewage and waste water treatment works. Of the twelve landfill sites identified in the region, only three are currently permitted. The status of these landfill sites should be reviewed as part of the proposed landfill permitting backlog project commencing in 2009. The regulation of these landfills will ensure that illegal and uncontrolled waste burning is minimised.

In order to minimise the impacts of waste burning, it is important to understand the impacts of emissions released from waste burning. Incineration of waste (municipal, medical, sewage and hazardous) can generate significant quantities of dioxins which have the potential for significant health effects. A comprehensive study of the health and environmental impacts of dioxins needs to be undertaken in South Africa and should incorporate reviews undertaken in other international countries.

Again, awareness campaigns around the environmental benefits of recycling should be promoted. These campaigns should focus on schools with recycling bins and depots installed at each school in the region. Proper refuse collection in all areas within the VTAPA will also minimise domestic waste burning in the informal settlements.

Emission reduction interventions for waste burning in the VTAPA are provided in Table 45 (see Table 61, Appendix B for the associated action plan).

Table 45: Emission reduction interventions for waste burning.

Intervention	Responsible Party	Timeframe	Progress
Introduction of tyre regulations.	DEAT (Chief Directorate: Pollution & Waste Management –Waste Stream Management)	Short term (2009)	DEAT - There is a draft Waste Tyre regulation developed by Pollution & Waste Management which is not yet in force.
Develop National legislation for dioxin control.	DEAT (Chief Directorate: Pollution & Waste Management –Waste Stream Management)	Short term (2009)	DEAT - This will form part of the Emissions Standards document to be gazetted in March 2009. In addition, Waste Stream Management is currently looking at emissions limits for cement kilns co-processing hazardous waste and for incinerators. No need for specific dioxin legislation for it will be dealt with through emission limits and priority areas AQMPs where measurements are high.
Develop an emissions inventory of waste burning sources (incinerators, sewage and waste water treatment works)	SDM, FDDM, COJ	Short term (2009)	SDM – to coordinate. LMs to develop database FDDM – Target 12/2008
Incineration policy.	DEAT (Chief Directorate: Pollution & Waste Management –Waste Stream Management)	Short term (2009)	DEAT - Waste Directorate is currently developing an incineration policy.
Landfill permitting backlog project	DEAT	Short term (2009)	
Use music, art, poetry and drama to disseminate information	DEAT, SDM, FDDM, COJ	Short term (2009)	DEAT - part of Clean Fires Campaign SDM – to coordinate FDDM – to form partnerships with arts activist
Undertake a comprehensive study on the impact of dioxins.	DEAT (Chief Directorate: Pollution & Waste Management –Waste Stream Management)	Short – Medium term (2012)	DEAT - Waste Stream Management is currently looking at dioxin emissions limits for the country using the internationally accepted "Dioxin Toolkit" developed through UNEP. This will give an estimate of the total dioxin emissions in the country and will identify priority areas.
Proper refuse removal by Local Authorities	SDM, FDDM, COJ	Short – Medium term (2012)	FDDM – Integrated Waste Management Plan (IWMP) completed SDM – function for LMs – ongoing cleaning projects
Create awareness around recycling	SDM, FDDM, COJ	Short – Medium term (2012)	SDM – to coordinate. LMs awareness campaigns rerating to reduce-, reuse, recycle of waste products in the region FDDM – IWMP completed. Projects will now be implemented
Vaal Environmental Justice	DEAT	Short – Medium	

Intervention	Responsible Party	Timeframe	Progress
Alliance (VEJA) - DEAT school programme		term (2012)	
Use energy from waste burning to generate electricity	DEAT & DME	Long Term	

Notes:
SDM – Sedibeng District Municipality
COJ – City of Johannesburg Metropolitan Municipality
DEAT – Department of Environmental Affairs and Tourism
FDDM – Fezile Dabi District Municipality
GP – Gauteng Province
FSP – Free State Province

5.3.10 Governance

5.3.10.1 Proposed Interventions

Capacity within all spheres of Government, in terms of resources, tools and finances, needs to be developed. It is essential that a separate, dedicated air quality division within each level of Government be established to focus on specific air quality management and control issues. Within this division, personnel need to be skilled and trained, with at least one Air Quality Officer. Local education institutions need to hold courses and workshops that are aimed specifically at air quality and meteorological issues. In addition, emissions inventory and dispersion modelling software needs to be obtained with the expertise to populate and operate such software. The City of Johannesburg is the only Municipality to have purchased the Cambridge Environmental Research Consultants emission inventory software (EMIT) and dispersion model (ADMS Urban). This Municipality has also undergone training on the software in collaboration with CERC. It is recommended that a similar course be held in the VTAPA with each Municipality sending representatives on the course. In addition, knowledge and information sharing between all Municipalities, both within the region and outside is crucial to ensure its success.

Recommended interventions are provided in Table 46 and action plans for the highlighted interventions are provided in Table 62 (Appendix B).

Table 46: Interventions to address Government capacity for air quality management.

Intervention	Responsible Party	Timeframe	Progress
Publication of National Ambient Air Quality Standards with allowable frequency of exceedances and implementation timelines.	DEAT	Short term (November 2008)	DEAT - Draft notice is finalised and approved by the minister. The draft is currently under discussion at the SABS and is likely to be gazetted for public comment in February 2009
Development of an implementation manual for the VTAPA AQMP to be distributed to the relevant local authorities	DEAT	Short term (September 2009)	SDM – LMs to develop business plans and repeat every quarter
National Framework Review and Publication of the National Framework	DEAT	Short term (11 September 2009)	National Framework review is currently taking place
Marketing of the priority area	DEAT	Short term (2009)	
A standardised air quality dispersion model – to be identified as part of the National	DEAT	Short term (2009)	

Intervention	Responsible Party	Timeframe	Progress
Framework and housed by DEAT within the short – medium term			
Publication of Listed Activities and National Emission standards	DEAT	Short term (2009)	
Finalisation of the APPA RC Review project and issuing revised RCs to the relevant industries	DEAT	Short term (2009)	
A standardised air quality dispersion model – to be identified as part of the National Framework and housed by DEAT within the short – medium term	DEAT	Short term (2009)	
Development of detailed action plans for all interventions as stipulated in the VTAPA AQMP to be incorporated into the revised AQMP.	DEAT, GP, FSP, SDM, FDDM & COJ	Short term (2009)	SDM has appointed consultants to identify and assess the resources and operational system requirements for the delivery of an effective air quality management service.
Review and update of VTAPA AQMP to include the detailed emission reduction strategies provided by industry and government	DEAT together with, GP, FSP, SDM, FDDM & COJ	Short term (2009)	SDM – all emission reduction strategies by industry and government to be capture in database
Establishment of a separate, dedicated air quality division within each level of Government whose specific functions are related to air quality management and control.	SDM, FDDM & COJ	Short term (2009)	SDM is in the process of establishing such as section. Capacity building is in progress. To be finalised in Midvaal. FDDM restructuring was approved in 2007. Coordinator: Municipal Health Services, Auxiliary services to deal with environmental pollution, including air pollution
Each sphere of Government to appoint a skilled, trained air quality officer (AQO)	SDM, FDDM & COJ	Short term (2009)	SDM – still in structural phase FDDM – designation to be finalised by June 2008
Detailed action plans to be developed for each intervention described	DEAT, GP, FSP, SDM, FDDM & COJ	Short term (2009)	SDM – need to develop FDDM – Air quality management plan process to start in last quarter of 2008
Air Quality Management courses to be held in collaboration with each Municipality and Province.	DEAT, GP, FSP, SDM, FDDM & COJ	Short term (2009)	SDM and GDACE have successfully completed the NACA/University of Johannesburg Air Quality Management Course. FDDM – attended all course/ workshops organised by DEAT
Regulations for the management of ozone depleting substances.	DEAT	Short term (2009)	DEAT - This is awaiting the completion of the functional analysis.
Emphasize prevention and improvement, not correction	DEAT	Short term (2009)	
Maximise enforcement and compliance (including EMIs)	DEAT	Short term (2009)	
Generic by-law development & modelling. A draft has been developed	DEAT	Short term (2009)	DEAT – a draft has been developed
Regulations in respect of the 'prescribed	DEAT	Short term	

Intervention	Responsible Party	Timeframe	Progress
form' for atmospheric impact reports		(2009)	
Institutional reform at Local Government Level – establishment of structure	SDM	Short term (2009)	
Setting up of the 'Emission Licensing Authority' in Sedibeng District	SDM	Short term (2009)	
Expand, upgrade and improve the first level emissions inventory developed for the VTAPA and to be housed by DEAT within the short – medium term	DEAT, in collaboration with SDM, FDDM & COJ	Short – Medium term (2012)	DEAT – still to take place SDM – advising industries on BAT technology in reducing emissions
Comprehensive health risk assessment to be conducted for the VTAPA based on hospitalisation records and updated population statistics	DEAT	Short – Medium term (2012)	DEAT – a project proposal is being drafted
Air Quality directives to be established in the priority regions	SDM, FDDM & COJ	Short – Medium term (2012)	SDM - still in development phase
Quarterly reporting to Councils on air quality in the area	SDM, FDDM & COJ	2008 - ongoing	
Improvement projects not to be delayed by full EIA processes and waiting for RODs	GDACE, FSP	Short – Medium term (2012)	
Installation of additional monitoring stations.	SDM & FDDM	Short – Medium term (2012)	SDM has re-commissioned one Opsis station. FDDM – Air quality management plan process to start in last quarter of 2008
SANAS accredited air quality monitoring stations	DEAT, GP, FSP, SDM, FDDM	Short – Medium term (2012)	DEAT – ambient air quality monitoring stations will be SANAS accredited – in progress
Institutional restructuring at Provincial Level to create a unit that specialises in air quality functions only	GP & FSP	Short – Medium term (2012)	
VEJA councillors programme	SDM, FDDM & COJ	Short – Medium term (2012)	
Widespread public awareness and education to mobilise people so that air quality issues become prioritised by politicians	DEAT, GP, FSP, SDM, FDDM & COJ	Short – Medium term (2012)	SDM – LMs ongoing educational programmes to be rolled out in the community
Develop ways of informing politicians (e.g. PCF) , raising awareness	DEAT, GP, FSP, SDM, FDDM & COJ	Short – Medium term (2012)	SDM – information sessions with politicians and through Section 80 meetings FDDM – air quality is a standing item in the Portfolio and Mayoral committees' meetings

Notes:
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LM – Local Municipality

5.3.11 Information Management

5.3.11.1 Proposed Interventions

The collection, management and dissemination of ambient air quality data and information need to be coordinated and managed as a whole in the region. Current ambient air quality monitoring practices in the Vaal Triangle are fragmented and uncoordinated with little financial and resource support. Limited skills and resources are available for air quality monitoring in the Vaal Triangle Airshed Priority Area. Operation, maintenance and calibration problems experienced at these stations have affected data collection and management. Ambient monitoring data from all stations needs to be transferred to an electronic, centralised database. This system will be developed as part of the South African Air Quality Information System Project (SAAQIS). All ambient monitoring data will be transferred and electronically database at the South African Weather Services.

All monitoring stations within the Vaal Triangle, both those operated by Government and industries, should be SANAS accredited. This will ensure that the correct monitoring and data management procedures are followed.

Other information management interventions include accessibility and dissemination of information through various media forms such as newspaper articles, Frequently Asked Questions booklets, and the internet.

Identified interventions to be implemented to address the gaps in information management are provided in Table 47 with an action plan developed for the highlighted interventions in Table 62 (Appendix B).

Table 47: Interventions to address gaps in air quality information management.

Intervention	Responsible Party	Timeframe	Progress
Quarterly AAQ progress report on National website and to stakeholders	DEAT	Short term (2009)	DEAT - SAAQIS project
A centralised, electronic complaint register database at all Municipalities.	SDM, FDDM & COJ	Short term (2009)	SDM is in the process of development. FDDM has budgeted R150,000 for developing an electronic complaints register
Conduct a comprehensive survey on the impact of air quality information/products by all stakeholders	DEAT	Short term (2009)	DEAT – still to be conducted
Source apportionment by chemical mass balance	DEAT & Eskom	Short term (2009)	
Epidemiological study initiated to establish baselines, current impacts and improvements as we clean the air (lead by DEAT – Eskom, other industries and Local Authorities to support)	DEAT, SDM, FDDM & Industry	Short term (2009)	SDM – research ongoing to determine effects of air pollution in the region
Comprehensive emissions inventory compiled and regularly updated as part of SAAQIS.	DEAT & South African Weather Services	Short term (2009) & ongoing	DEAT - A service provider has been appointed for compiling a comprehensive emission for GHG Hand-over of initial emissions inventory to DEAT to take place
Develop a 'Did You Know' website of air	DEAT	Short term (2009)	Partnerships to be formed with

Intervention	Responsible Party	Timeframe	Progress
quality information/data. This should include positive issues e.g. reduction of emissions etc setting up of communication system i.e. complaints with industry			local academic institutions
Wall newspapers	DEAT	Short term (2009)	
Community Information Strategy	VTAPA MSRG & AQOF	Short term (2009)	
Publish information on who's who in the air quality management industry in the area	DEAT	Short term (2009)	
Regulations relating to information management with regard to atmospheric emission licences.	DEAT	Short term (2009)	DEAT - This will form part of the regulations as soon as APPA is repealed
Sedibeng to have two operational air quality monitoring stations. Feed data into the data management system	SDM	Short term (2009)	
SANAS accredited monitoring methodologies and standard QA/QC	DEAT	Short – Medium term (2012)	DEAT – is participating in the SANAS process of revising accreditation documentation
Public access to all emission inventories. This will be through SAAQIS	DEAT	Short – Medium term (2012)	DEAT – still to be initiated through SAAQIS (Phase II)
Environmental literacy programme for learners and educators	DEAT	Short – Medium term (2012)	
Develop booklet of FAQ with responses from DEAT (updated regularly)	DEAT	Short – Medium term (2012)	
All monitoring stations to have meteorological equipment	SDM & COJ	Medium term (2012)	
All monitoring stations to be SANAS accredited	SDM	Medium term (2012)	
VEJA to feed back to all our affiliates	SDM, FDDM & COJ	Medium term (2012)	VEJA to provide feedback on matters of concern on a routine schedule to all relevant stakeholders
Development of an electronic, centralised air quality monitoring database.	DEAT & South African Weather Services	Medium – Long Term	DEAT - This will be developed as part of the South African Air Quality Information System (SAAQIS)
National upper-air meteorological network	DEAT	Medium – Long Term	DEAT – to be initiated

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6 AIR QUALITY MANAGEMENT PLAN IMPLEMENTATION STRATEGY

Following from the Baseline Assessment, this report outlines the required strategies and interventions for implementation in the VTAPA to address the current problems and information gaps identified during the initial air quality assessment. Eleven problem complexes were identified around which problem and objectives trees were developed. Interventions were then proposed for each problem complex. These interventions were informed from the outcome of the Baseline Assessment, through input from various stakeholders as well as the co-operation of major industrial sources in the region. It is recognised that these interventions need to take into account current National air quality projects.

6.1 Capacity Building within Government

6.1.1 Resources and Tools

An AQMP cannot be successfully implemented and revised in the absence of an effective air quality management system (Figure 37). Essential tools in an air quality management system include an emissions inventory, dispersion modelling and source and ambient air quality monitoring. Capacity, in terms of resources and finances, within the VTAPA needs to be developed to ensure the effective implementation of the AQMP.

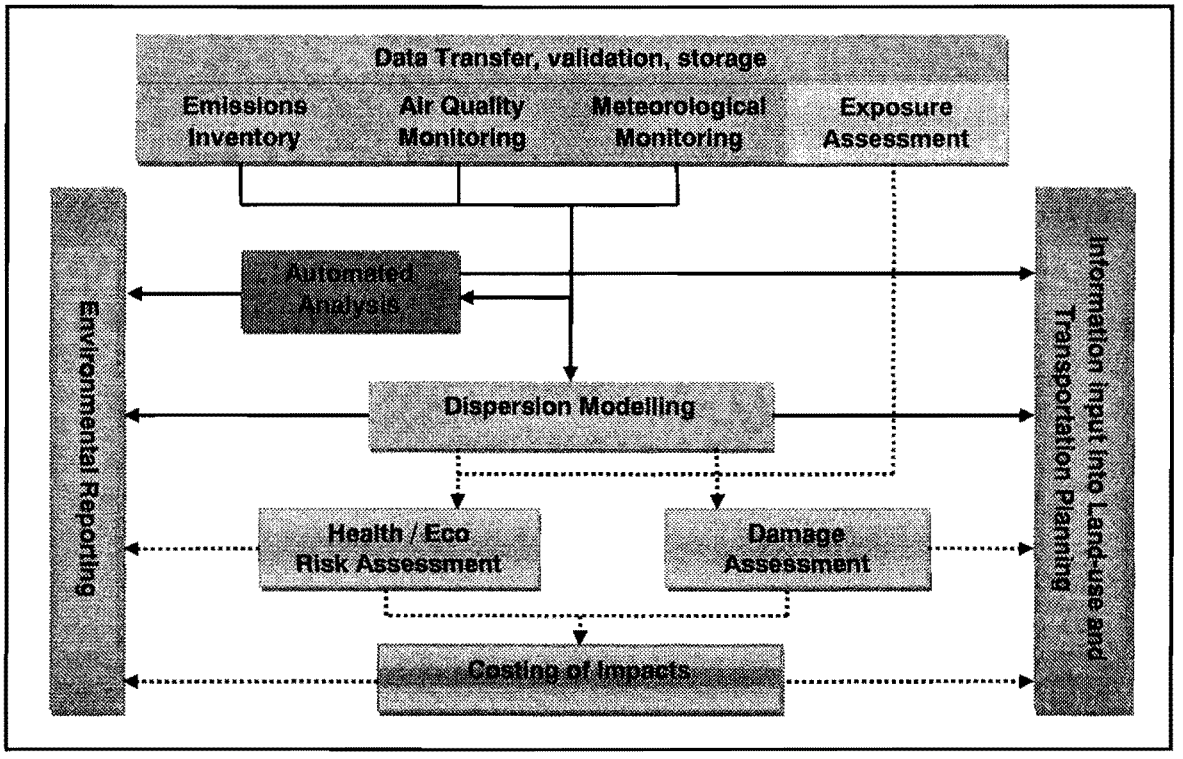

Figure 37: An Air Quality Management System for implementation in the Vaal Triangle Airshed Priority Area.

6.1.1.1 Ambient Air Quality Monitoring

An ambient air quality management system consists of various hardware, software, communication systems as well as activities related to the ongoing maintenance and calibration of the system. Continuous ambient air quality monitoring requires among other things; a set of trace gas analysers housed in a secure shelter, meteorological equipment, a data communication and acquisition system, as well as various other mechanical, civil and electrical structures such as an inlet manifold, fencing, concrete plinth, air conditioner, Uninterrupted Power Supply (UPS) and safety devices such as a lightning conductor. As part of a monitoring network design (macro and micro-siting) it is important to consider the following aspects:

- Proximity to residential areas,
- Location of industries, major roads, sources of domestic fuel burning emissions etc,
- Dominant wind direction,
- Dispersion modelling results,
- Topography,
- Location of existing monitoring stations,
- Sensitive environments,
- Sensitive populations,
- Trans-boundary impacts from sources outside the Vaal Triangle Airshed Priority Area.

6.1.1.2 Continuous Ambient Air Quality Monitoring

Continuous ambient air quality monitoring of atmospheric emissions ensures that the environment is being properly protected and helps Local Government manage their impact on the environment. This type of monitoring provides continuous, accurate data on pollution concentrations at a specific location. However, limitations of this type of monitoring are associated with spatial coverage, technical skills required for maintenance and calibration as well as the ongoing financial implications.

Municipalities would need to acquire air monitoring equipment as well as a system that will automatically retrieve air quality data from loggers and sensors for the management of remote data acquisition equipment. This system should have data correction functions for quality assurance. An ambient air quality monitoring station requires a person responsible for maintaining the network, calibrating the instruments as well as analysing data and compiling reports for compliance assessment.

An ambient air quality monitoring station requires ongoing maintenance and calibration and is not just a once-off capital expense; this should be budgeted for at the onset of the project. Approximate costs associated with the installation, operation and maintenance of a complete ambient air quality monitoring station have been provided in Table 42 and 43. At a minimum, it is recommended that any new ambient monitoring station to be installed in the priority area should measure a range of pollutant and meteorological parameters including:

- PM_{10}, $PM_{2.5}$, SO_2, NO_x (NO and NO_2), BTEX, CO and O_3
- Wind speed, wind direction, temperature, humidity, pressure and rainfall

The calibration of the stations should be undertaken on a regular basis, with zero and spans performed every two weeks and a full dynamic calibration undertaken every three months. In addition, all stations should obtain SANAS accreditation to ensure the standardisation of monitoring practices in the region.

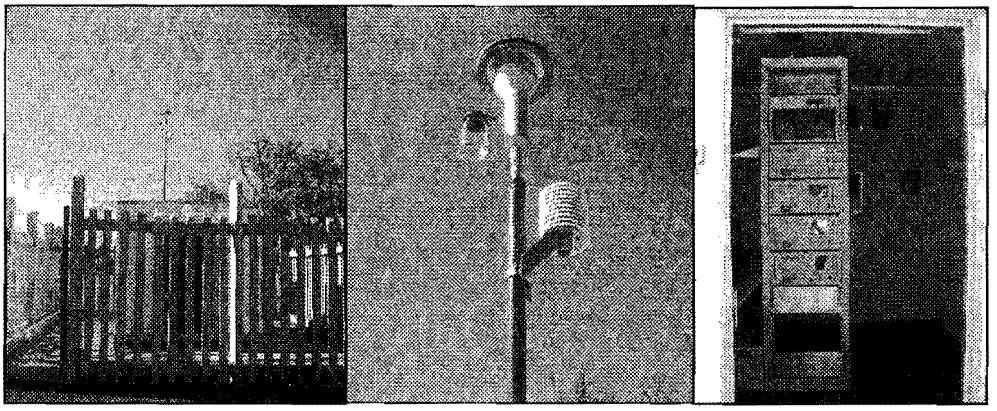

Figure 38: Continuous ambient air quality monitoring equipment.

Table 48: Equipment and associated costs (once off) for the installation of a complete ambient air quality monitoring station.

Requirements	Unit	Approximate Price
Equipment		
Trace Gas Analysers (SO_2, NO_x, O_3 and CO)	Four analysers	R 340 000 – R 550 000
PM_{10} Instrument (Beta Gauge)	Per instrument	R 140 000
$PM_{2.5}$ Instrument	Per instrument	R 150 000
Gas Chromatograph (VOCs)	Per instrument	R 250 000
Meteorological station (inc. wind speed, wind direction, temperature, humidity, radiation, pressure and rainfall and mast)	Per station	R 60 000
Installation		
Civils (concrete plinth and fencing)	Once Off	R 50 000
Shelter, air conditioner, glass inlet manifold, UPS and alarm system	Once Off	R 150 000
TOTAL		**R 1 005 000 – R 1 350 000**

Table 49: Operational and maintenance costs (annual) of a complete ambient air quality monitoring station.

Requirements	Unit	Approximate Price
Operation and Maintenance		
Zero and spans every two weeks (outsourced).	Every two weeks	R 60 000
Full Dynamic Calibration (every three months)	Every three months	R 25 000 – R 30 000
SANAS accreditation calibration	Once off	R 9 000 – R 12 000
Consumables, maintenance and repairs	Per annum	R 40 000 – R 50 000
Software		
Data acquisition and communication	Per annum	R 100 000
TOTAL		**R 244 000 – R 252 000**

6.1.1.3 Passive Diffusive Monitoring

Passive monitoring is an inexpensive method of monitoring over a large area and requires little human intervention (Figure 39). Passive badges can measure a range of pollutants including SO_2, NO_2, O_3, hydrogen sulphide (H_2S), hydrochloric acid (HCL), VOCs, and various aldehydes among others. Passive diffusive sampling calculates an average reading over a time period as opposed to real-time data acquisition that continuous monitoring can provide. Passive badges have to be sent away to an accredited laboratory for analysis further extending the lag time in getting results (2 to 3 weeks). Passive sampling conforms to international methodologies and standards and can be used to validate dispersion modelling results.

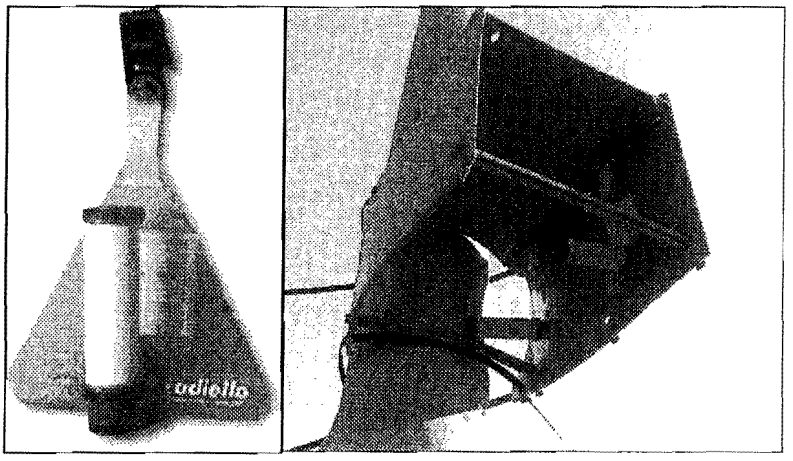

Figure 39: Passive badge sampling equipment.

6.1.1.4 Diesel Vehicle Testing

Vehicle monitoring, in particular, diesel smoke testing, is an effective method to determine if vehicle emissions are acceptable. Traditionally, testing of diesel vehicle emissions has been undertaken using a Hartridge smokemeter in accordance with the requirements of APPA (~R80 000). Diesel vehicle testing can also be undertaken using the mobile Smoke Check 1667 instrument. An important criterion is that the instrument should be able to measure smoke from turbocharged diesel-driven vehicles.

6.1.2 Ambient Air Quality Management

6.1.2.1 Emissions Inventory

A first requirement for effective air quality management and control is the establishment of a comprehensive, accurate and electronic emissions inventory of all identified sources. An emissions inventory includes information on source parameters and associated pollutant emission rates. Source and emissions data needs to be collated for routine, upset and accidental emissions to provide a representative account of the potential for impacts that exist. Emission inventories represent the main elements in all programmes aimed at air pollution management, aiding in the identification of sources and pollutants of concern and therefore in the selection of effective air pollution mitigation measures.

There are two general approaches to the development of an electronic emissions inventory:

- Emission estimation using various emission models - manual integration into common emissions inventory data base,
- Selection of an existing emissions inventory database - includes emission estimation algorithms for all required sources. However, it is important to ensure that these algorithms can be adapted to local conditions.

Given that a first level emissions inventory has been developed for the VTAPA as part of the baseline assessment it is recommended that this emissions inventory be updated and expanded to include all the sources of emissions. The first option is recommended since various emission quantification methods were used to develop this first level emissions inventory for the VTAPA. In the short to medium term the focus should be on the addition of sources and pollutants to the database with the upgrading off it aimed for the medium to long term. All sources of atmospheric emissions should be identified and quantified, including point and non-point sources.

It is recommended that the local tertiary institutions within the VTAPA be used in assisting with information gathering. The emission questionnaires as used in the baseline can be used and refined and send out to the various identified sources. Students (specifically post-graduate students) can be used as part of the information collection process i.e. following up on sources and doing field-work by identifying sources not on the list. Student can also be used for traffic counts to update the vehicle emissions with. This will form part of the awareness campaign and education in air quality management. It is however important that the emissions inventory development be done by DEAT and the skills developed in house in order to transfer these skills to the local government sector.

The emissions inventory should eventually be linked with SAAQIS to form part of a central database. It is important to link the emissions inventory to a GIS System (likely to be part of SAAQIS) for spatial representation of all sources of emissions. It is further recommended that as part of this spatial database, the Atmospheric Emissions Licences (AELs) be linked for all relevant sources and an indication of compliance or non-compliance.

6.1.3 Atmospheric Dispersion Modelling

Atmospheric dispersion modelling forms an integral component of air quality management and planning. Dispersion models calculate ambient air concentrations primarily as functions of source configurations, emission strengths, terrain features, and meteorological characteristics.

Dispersion modelling is typically used to determine compliance with ambient air quality standards, assist in health and environmental risk assessment, provide information for monitoring network design and to assess source contributions to air quality concentrations. Very important for local authorities is the use of dispersion models to assist with land-use planning, specifically for future planning scenarios and "what if" investigations. It can also be used to delineate of buffer zones around existing emissions sources or areas where no additional sources should be allowed

Locally, a range of urban airshed models are currently being utilised, including ADMS Urban by the City of Johannesburg, Ekurhuleni Metropolitan Municipality and the City of Cape Town, the Norwegian AirQuis model by eThekwini Metropolitan Municipality and the locally developed DAPPS model, the latter not currently available for purchase. Other US.EPA regulatory models such as CALPUFF and AERMOD are downloadable from the US.EPA website. CALPUFF is designed to model long-range transport of pollutants and is most applicable in large areas and areas of complex terrain. AERMOD, which has replaced ISC as the USEPA approved regulatory Gaussian model is a straight plume model more accurate in smaller modelling domains and near field impact predictions (i.e. up to 20 km).

When selecting an appropriate model for the Vaal Triangle Airshed Priority Area, the following considerations should be taken into account, including:

- Applicability to the local environment, in particular, an urban airshed,
- Compatibility with a GIS such as ArcGIS,
- Compatibility with an emissions inventory software,
- Availability of meteorological data (i.e. should upper air data be required),
- Accessibility to software support (local and international),
- Chemical reactions such as O_3 formation,
- IT requirements.

The CALPUFF/CALMET suit of models was used in the baseline assessment of the VTAPA. Even though these models are considered to be labour and data intensive, it is important that the same model be used throughout to ensure consistency. Regulatory models mean that the uncertainties of the modelling predictions have been tested and recorded and hence, due to the different algorithms included in the various models (depending on the complexity the model can handle) the predicted concentrations will vary (within a certain range) between the various models. It is therefore recommended that the CALMET/CALPUFF model used for the baseline prediction in VTAPA be housed at DEAT in the short to medium term. A dispersion modeller should be appointed to manage, update and run the model. The model results should be linked to the GIS System and the information made available to the public. This should also eventually be incorporated into the SAAQIS system.

6.1.3.1 Brief description of the available dispersion models

ADMS

ADMS is applicable for local/small-scale applications. Features of ADMS include:

- PC-based, Gaussian plume dispersion model,
- Models the dispersion of pollutants released from point line and area sources within urban areas,
- Models complex terrain using the FLOWSTAR model
- Account for chemical reactions between NO, NO_2, O_3, VOCs and the formation of secondary sulphate particles from SO_2.
- Meteorological pre-processor calculates the required boundary layer parameters from input data which includes wind speed, day, time, cloud cover or wind speed, surface heat flux and boundary layer height

Validation studies have been carried out by Carruthers *et al* (1999, 2003) in London which showed good agreement between the modelled and observed results. Hanna *et al* (2001) undertook an evaluation of the ADMS, AEROMOD and ISC3 models. ADMS was found to under predict on average by 20%, with a scatter of about a factor of 2. ADMS has 53% of its predictions within a factor of 2 of observations.

AirQuis

The Air Quality Information System, AirQuis, was developed by the Norwegian Institute for Air Research (NILU). The model is applicable for urban and industrial environments. A major component of the AirQuis system is the dispersion models which can account for vehicle emissions, industrial emissions and household related emissions. The system can also estimate population exposure to air pollution.

The source oriented numerical dispersion model EPISODE (a time-dependent finite difference model) calculates the spatial distribution of pollutants, hourly, from a number of sources (point, line and area sources). It uses a sub grid line source model for traffic (ROADAIR) and a puff trajectory model (CONTI-LENK) for industrial sources to account for grid (1 km square grid) effects close to individual sources. The photochemical reactions for NO_2 is based on a standard photochemical equilibrium model using reaction rates (based on the amount of solar radiation) between NO, NO_2 and O_3. Output from the model can be linked to a GIS system and modelled data output can also be retrieved and placed on to a dedicated web page.

The model has been applied in various studies including Norway, Sweden, China, Botswana, Israel and a number of European cities. It has been used in urban air quality studies and in various health studies linking short term health effects with air pollution conditions in several Norwegian cities. The EPISODE model has been evaluated by comparing the modelled concentrations of NO_x and NO_2 with monitored data in Oslo (Larssen *et al.*, 1994). The model showed good agreement with monitored data, with correlation values for NO_x ranging between 0.48 and 0.80 and NO_2 between 0.48 and 0.76.

CALPUFF

CALPUFF is an advanced, integrated, non-steady-state Gaussian puff modelling system consisting of three main components and a set of pre-processing and post processing programs. The main components are CALMET (a diagnostic three-dimensional meteorological model), CALPUFF (a puff dispersion model) and CALPOST (a postprocessor package). It models the dispersion of gases and particles using time and space varying meteorological conditions based on turbulence, emission strengths, pollution transport, transformation and removal.

The model is designed to simulate the dispersion from point, area, volume and line sources integrating the effects of plume rise, partial penetration, buoyant and continuous plume rise and stack effects. It can be applied for long range transport (tens to hundreds of kilometres) and complex terrain. It includes algorithms for sub-grid scale, longer range effects (such as wet and dry deposition, chemical transformation and visibility effects) and downwash effects by buildings.

The US.EPA has recommended CALPUFF for long range transport modelling (greater than 50 km from the emission source) due to its ability to process complex three-dimensional wind fields (US.EPA, 2002). Chemical transformations are modelled using a pseudo-first-order chemical reaction mechanism, in MESOPUFF, for the conversion of SO_2 to SO_4^- and NO_x to NO_3^-. However, the model is not recommended for use in estimating the impact of NO_x and SO_2 on secondary particulate formation less than 10 km from a source. The model can also utilise user defined diurnal cycles of transformation rates.

AERMOD

AERMOD is a steady-state Gaussian plume dispersion model based on the atmospheric boundary layer turbulence structure and scaling concepts and is designed to use vertical profiles of measured wind speed and turbulence. AERMOD has replaced the Industrial Source Complex Short Term (ISCST3) model as the US.EPA's approved regulatory dispersion model. The model estimates pollutant concentrations at receptor points for averaging times from 1 hour to multiple years. It is able to model rural and urban areas, simple and complex terrain, surface, near-surface and elevated releases and multiple sources (including point, area and volume sources). The model also takes building effects into account using PRIME (Plume Rise Model Enhancements) which is an algorithm used to model downwash created from flow around buildings. The model also includes dry and wet deposition of gases and particles.

AERMOD has been used in various dispersion modelling studies in the United States (US) and around the world including Philadelphia, California, San Francisco, Indiana, New York, Pennsylvania and Nevada, Argentina and South Africa. A study by Ventrakam (2003) investigated the ability of the AERMOD to model the dispersion of an inert gas, released as a line source, in an urban environment. Comparing monitored and modelled concentrations at 24 receptor locations it was found that the model over predicted average 30 minute concentrations near source and under predicted concentrations further away. The study also found that at night the correlation of measured and modelled concentrations at the closets receptor points to the source were poor. However, the agreement improved with distance (Holmes and Morawska, 2006).

6.2 Human Resources

For this AQMP to be effective, co-operative governance and political buy-in across all spheres of government will be required, as well as the capacity to enforce compliance with the new legislation. It is recognised that air quality management and control is primarily a function of the Local Municipalities with emission licensing functions undertaken by District and Metropolitan Municipalities. In order to increase the capacity in Local Government, authorities need to invest both time and capital. For Municipalities to fulfil their regulatory role in terms of air quality, dedicated personnel need to be appointed. As required by current legislation, Air Quality Officers must be appointed within National, Provincial and Local Government.

Universities and Technikons do not have dedicated courses and degrees in Air Quality Management and Modelling. Courses in Atmospheric Chemistry and Environmental Management specific to air are only part of other courses. Environmental Health Practitioners (EHPs) are trained specifically on occupational health and safety issues with little focus on ambient air quality issues. Certain universities such as the University of

Johannesburg and the University of Potchefstroom offer short courses in air quality management. All newly appointed Air Quality Officers should be sent to undergo such training.

The implementation, co-ordination and management of the roll-out of the AQMP will require specific functions and capabilities within the Local and District Municipalities, personnel appointments at various levels may be required to be able to fulfil their mandate as air quality authorities. Such personnel should have the following requirements and responsibilities:

- **Air Quality Officers (AQO)**

This person should have specialised technical skills with specific relevance to industry (on all the aspects of air quality management, i.e. emissions inventory, modelling, monitoring, control technology etc.).

Tasks

The AQO is responsible for coordinating matters pertaining to air quality management. The AQO does not have to be a specialist air quality manager but must ensure that such specialists are available to ensure that air quality governance is carried out efficiently and effectively. The AQO should however have knowledge of air quality management.

- Responsible for air quality management in the municipality
- Middle to senior level manager
- Person who has broad knowledge and understanding of air quality related issues and air quality management
- Have to represent and negotiate municipality positions in meetings with other AQO's
- Must have sufficient authority to make decisions on day-to-day air quality issues
- Coordinate and standardise air quality functions undertaken across regions
- Review of provisional emissions licenses and atmospheric emissions licenses, and subsequently may request atmospheric impact reports
- May establish programmes for public recognition of significant achievements in the area of pollution prevention
- Manage central database comprising statistics and legal action taken by regions
- Periodic review of capacity within regions to undertake air pollution control functions and coordinate capacity building
- Provide support in terms of the interpretation and enforcement of legislation and regulations related to air pollution control
- Licensing and control of non-domestic fuel burning and listed activities

- **Technicians**

This person should have both management and technical skills, with particular emphasis on maintenance and operation of ambient air quality monitoring stations

Tasks

- Manage lab
- Coordinate external calibrations
- Administration of accreditation document
- Perform zero and spans and full dynamic calibrations
- General station and instrument maintenance
- Validate and analyse data from monitoring stations

- **Atmospheric Scientists**

This person should have technical skills in emissions inventory development, dispersion modelling, database management and GIS (persons per task could also be appointed)

Tasks

- develop and maintain an on-going comprehensive emissions inventory (identification and quantification of all sources) - report to common AQ database
- rankling of sources and reduction opportunities based on emissions inventory
- integration of emissions inventory and air quality and meteorological monitored data into common database,
- dispersion modelling (simulation of ground level concentrations) for compliance assessment
- evaluate dispersion modelling results based on ambient monitored data
- review ambient monitoring station locations based on dispersion simulations
- rank sources based on ambient concentrations and determine reduction measures required for compliance

- **Air quality Information Officer**

This person should have data management and communication skills

Tasks

- Inventory air quality related complaints receive via "one stop service"
- Coordinate responses to air quality related complaints received
- Collate and disseminate information to newspapers and radio stations
- Ensure information is routinely reported for display on website
- Organise and facilitate public meetings
- Assist in the design and implementation of awareness raising campaigns

6.3 AQMP Review Requirements

The Final AQMP will be published in the Government Gazette for public comment once it has been approved by the Minister.

The functional and operational framework within which the plan is implemented will be reviewed regularly to ensure its continuing suitability, adequacy and effectiveness. The plan review should further include current and future economic realities. The aim of the review is primarily to address the possible need for changes to functional and operational structures, AQM systems, management objectives (etc.) in light of poor performances, changing circumstances and the commitment to continual improvement.

Given the limitations and constraints around the baseline assessment and subsequently the intervention descriptions, the VTAPA AQMP will be revised within two years of publication. The plan will be reviewed based on the:

- final stipulations within the National Air Quality Management Act;
- national regulations pertaining to revised ambient air quality standards;
- national regulations pertaining to ambient air quality monitoring for compliance assessment purposes;
- national regulations pertaining to listed activities and emission standards;

- national regulations for source monitoring methods suited to assessing compliance with emission standards;
- proposed guidance reports to be issued on: (i) air quality assessments, (ii) the use of indirect methods for air quality characterisation (e.g. modelling), and (iii) air quality management plan development and implementation; and,
- detailed intervention descriptions and action plans as to be provided by the various industries, mines and government divisions.

The VTAPA AQMP will initially be revised in two years after the first revision, following which it will be revised every 5 years unless otherwise required by DEAT.

6.4 Implementation of the AQMP

The MSRG and AQOF for the VTAPA will meet every 2 months to report on progress made on the implementation of the plan. Any reasons that prohibited the implementation of the plan will be reported and solutions sourced to ensure compliance with the implementation requirements. This will be documented and minuted to ensure it is included into the following review of the plan. The membership lists of the MSRG and AQOF are provided in Appendix A. Progress made in AQMP implementation will be reported on annually to all stakeholders.

7 CONCLUSION

An AQMP was developed for the VTAPA during 2007 and 2008. The main objective was to develop a plan that will ensure, once implemented, that air quality in the area will be brought into sustainable compliance with ambient air quality objectives and within agreed timeframes.

The development of the VTAPA AQMP followed a participatory approach through the development of an Air Quality Officers Forum and a Multi Stakeholder Reference Group and identification of interested and affected parties. The Air Quality Officers Forum and a Multi Stakeholder Reference Group met every month during the development of the plan, and will meet every second month during the implementation of the plan. In addition, two public workshops were held, allowing all stakeholders to partake in the process.

The AQMP is based on scientific data obtained from the baseline characterisation study conducted in 2007. All sources of emissions were identified and quantified with dispersion modelling conducted to determine the current state of air quality within the Vaal Triangle. This was done for the criteria pollutants of PM_{10}, SO_2 and NO_2. The predicted concentrations were verified through available ambient monitoring data. Predicted PM_{10} ground level concentrations exceeded the VTAPA air quality objectives within six areas, called "hotspot zones". Exceedances of acute SO_2 and NO_2 concentrations were predicted in localised areas. The main contributing sources were identified and the percentage reductions required to bring the ambient air quality in line with the air quality objectives were calculated. Based on this, all contributing sources developed emission reduction strategies which were included into the final intervention strategies. The various spheres of government responsible for the implementation of the plan were assessed in terms of capacity, organisational structures, systems and air quality management tools.

In addition to the impact zones, eleven problem complexes were identified i.e. (i) Biomass Burning, (ii) Domestic Fuel Burning, (iii) Iron and Steel, and Ferroalloys, (iv) Mining, (v) Petrochemical, (vi) Power Generation, (vii) Small Industries, (viii) Transportation (ix) Waste Burning (x) Government Capacity for Air Quality Management, and (xi) Information Management. A problem tree was established for each problem complex and turned into an objectives tree for which strategies and interventions were developed. The emissions reduction strategies were linked to the intervention strategies within the relevant problem complex. The intervention strategies included an implementation timeframe, the parties responsible for the intervention and the current status. A number of interventions within each problem complex were expanded into action plans providing assumptions associated with the intervention strategy, estimated costs, timeframes and indicators.

An implementation manual was drafted to assist national, provincial and local authorities in the implementation of the VTAPA AQMP. The plan will be reviewed within 2 years, realigning the intervention strategies to ensure continuous improvement in ambient air quality.

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APPENDIX A: MEMBER LIST OF THE VTAPA AIR QUALITY OFFICERS FORUM AND MULTI-STAKEHOLDER REFERENCE GROUP

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APPENDIX B: INTERVENTION ACTION PLANS FOR THE ELEVEN PROBLEM COMPLEXES

Table 50: Action plan for selected interventions identified for Biomass Burning

BIOMASS BURNING							
Intervention	*Implementation Strategy*	*Responsible*	*Assumptions*	*Estimated Cost*	*Timeframe*	*Control Efficiency*	*Indicators*
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
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
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

Table 51: Action plan for selected interventions identified for Domestic Fuel Burning

DOMESTIC FUEL BURNING							
Intervention	*Implementation Strategy*	*Responsible*	*Assumptions*	*Estimated Cost*	*Timeframe*	*Control Efficiency*	*Indicators*
Basa Njengo Magogo (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	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 PM_{10} 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
	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 PM_{10} and 20% for other pollutants	60% of households reached PM_{10} ambient monitoring data in Zamdela to indicate annual average reductions over 2008/9
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% PM_{10} and SO_2 reduction	PM_{10} and SO_2 ambient monitoring data in Orange Farm and Zamdela indicates a reduction

Table 52: Action plan for selected interventions identified for ArcelorMittal (Iron and Steel Sector)

ARCELORMITTAL - IRON AND STEEL INDUSTRY				
Emission Reduction Intervention	*Full Description of the Emission Reduction Intervention*	*Compliance Date (Day/ Month/Year)*	*Estimated Cost*	*Comments /Progress*
• 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)
• 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
• 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 effects 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 blast furnace was experienced, mainly because of improved coke strength.		Operational costs	Target date Feb 2006 Completed
• 25% Demonstration Unit for proof of performance at the Sinter Plant (Mitigation projects	• 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		+/- R 66 million	Target date October 2009 ?

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Emission Reduction Intervention	*Full Description of the Emission Reduction Intervention*	*Compliance Date (Day/ Month/Year)*	*Estimated Cost*	*Comments /Progress*
on PM_{10})	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.			
• 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, CO_2 & 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
• 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

Table 53: Action plan for selected interventions identified for the mining sector

METALLOYS - FERROMETAL INDUSTRY				
Emission Reduction Intervention	*Full Description of the Emission Reduction Intervention*	*Compliance Date (Day/ Month/Year)*	*Estimated Cost*	*Comments /Progress*
• 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)	R3mio	Implementation phase to be prioritized according to integrated rehabilitation 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	R5mio	Completed on time
• 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	R0.6mio	Completed in 12/2008
• 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 >>R15mio	Due to cost escalation and revised scope referred to ERS rev 2 project Front End Loading (see below)
• 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	R0.3mio	Completed on time
• 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)	R1.5mio	Completed on time
• 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 R6.5mio	Delayed due to cost escalation and required re-tender, currently in procurement phase, revised completion target 8/2009
• 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	R0.5mio	Completed on time
• PM_{10} source identification	• Short term ambient air PM_{10} monitoring project to assist in emission source identification	Completion target date was 02/2008	R0.1mio	Completed on time
• Emission Inventory update	• Comprehensive Emission Inventory update based on data	Completion target date was	R0.1mio	Completed on time

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Emission Reduction Intervention	*Full Description of the Emission Reduction Intervention*	*Compliance Date (Day/ Month/Year)*	*Estimated Cost*	*Comments /Progress*
	collected during APPA permit review	02/2008		
• Dispersion modelling	• Dispersion modelling of current baseline	Completion target date was 03/2008	R0.1mio	Completed in 04/2008
• 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	R0.05mio	Completed in 09/2008
• 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	R0.5mio	Completed in 07/2008
• 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 R3mio	On target for tall gate one approvals
• 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 >> R100mio)	Not yet applicable
• 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	R0.5mio	Completed

Table 54: Action plan for selected interventions identified for New Vaal Colliery (mining sector)

NEW VAAL COLLIERY – MINING SECTOR				
Emission Reduction Intervention	*Full Description of the Emission Reduction Intervention*	*Compliance Date (Day/ Month/Year)*	*Estimated Cost*	*Comments /Progress*
• Dust fallout monitoring programme	• Operation of a dust fallout monitoring programme, consisting 32 single and 9 directional dust bucket monitoring network	Ongoing (short term)		
• 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		
• Dust suppression technologies	• Implementation of dust suppression technologies including: o Three water tankers running 24 hours/day to spray haul roads — Ongoing o Use of water sprays at plant conveyor belt transfer points — Ongoing o Wetting and compaction of seasonal coal stacks in stockyard — Ongoing o Use of a fogging cannon at tip and/or stacker/reclaimers — Ongoing as required o Use of up to 5 water cannons at working faces — Ongoing as required o Dust-a-side application on haul roads. Current 8km; total planned 13.8km — End 2008 o 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 — End 2008 o Project: Dust hood installed at secondary crushers. Motor damper arrangement to be finalized — End 2008			
• Dust-a – side application on Haul roads	• Current 8km, total planned 13.8 km	Ongoing (short term- end 2008)		
• Buffer blasting programme	• Implementation of buffer blasting programme to minimise ingress of air into old workings	Ongoing standard operating procedure		
• 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	End 2008		

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Emission Reduction Intervention	*Full Description of the Emission Reduction Intervention*	*Compliance Date (Day/ Month/Year)*	*Estimated Cost*	*Comments /Progress*
	of conveyor belt curtain top be completed.			
• 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		
• 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		

Table 55: Action plan for selected interventions identified for SASOL (Petrochemical Industrial Sector)

SASOL – PETROCHEMCIAL INDUSTRY SECTOR				
Emission Reduction Intervention	*Full Description of the Emission Reduction Intervention*	*Compliance Date (Day/ Month/Year)*	*Estimated Cost*	*Comments /Progress*
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		
• 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
• 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 mil with annual operational costs of R 1.5 mil	The data from the residential stations will be made available to SAAQIS
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
• 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.

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Table 56: Action plan for selected interventions identified for NATREF (Petrochemical Industrial Sector)

NATREF – PETROCHEMCIAL INDUSTRY SECTOR				
Emission Reduction Intervention	*Full Description of the Emission Reduction Intervention*	*Compliance Date (Day/ Month/Year)*	*Estimated Cost*	*Comments /Progress*
• 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
• 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

Table 57: Action plan for selected interventions identified for OMNIA Fertiliser (Petrochemical Industrial Sector)

OMNIA FERTILISER – PETROCHEMCIAL INDUSTRY SECTOR				
Emission Reduction Intervention	*Full Description of the Emission Reduction Intervention*	*Compliance Date (Day/ Month/Year)*	*Estimated Cost*	*Comments /Progress*
	Short Term (2008/2009) • Although not required in terms of the proposed VTAPA management plan, Omnia is committed to reduce its NOx emissions by at least 80% from the 2007 emission loads through the installation of appropriate abatement technology • Installation of online monitoring equipment at the nitric acid plant • Reduction of fugitive dust emissions in certain areas of the granulation plants through the systematic implementation of improvement practices • Reduction in the fluoride emissions through the installation of improved scrubbing technology at the	2008/2009	NOx abatement technology installed and accredited In progress – will be complete by end 2009 Continually done In progress	

	Superphosphate plat • Installation of monitoring equipment on the granulation plants to improve the measurement and management of dust emissions		Already completed	
	Medium to long Term (2009 to 2012) • Roll out of improvement practices to other areas within the granulation plants to further reduce dust emissions • Evaluate Granulation Plant 2 stack emissions and investigate best practical environmental option • Evaluate best practical environmental options for material loading and offloading activities • Promote increased awareness amongst employees and communities through targeted initiatives and awareness campaigns These interventions should ensure a reduction of 2.5% in PM_{10} emissions compared to 2007 emissions, as required.	2009 to 2012		

Table 58: Action plan for selected interventions identified for ESKOM (Power Generation Sector)

ESKOM – PETROCHEMCIAL INDUSTRY SECTOR				
Emission Reduction Intervention	*Full Description of the Emission Reduction Intervention*	*Compliance Date (Day/ Month/Year)*	*Estimated Cost*	*Comments /Progress*
Emission reductions and air quality management measures implemented by Lethabo/Eskom				
• 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
• 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
• 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
• 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
• 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
Emission reduction and air quality management measures to be undertaken by Lethabo/Eskom				
• 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	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

	emission licence to be assessed • **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. • **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 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: a. Sulphur dioxide gas analyser b. Nitrogen oxide gas analyser c. Beta gauge for monitoring of PM_{10} The air quality instruments will be installed in a standard	August 2009		A report on the commissioning of the monitoring station will be compiled. 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 submitted to SAAQIS, when operational.

	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. 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. 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 • **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.	August 2009		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 (or increase the 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. • **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. • **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 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	This has a net present value of around R9 billion, assuming a 30-year life 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.		If coal beneficiation is feasible, steps will be taken to implement it.

	electricity.			
• 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; 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 temperature must remain within the minimum requirements in terms of indoor air quality	Ongoing		

	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		

Table 59: Action plan for selected interventions identified Smaller Industries and Commercial Operations

SMALL INDUSTRIES							
Intervention	*Implementation Strategy*	*Responsible*	*Assumptions*	*Estimated Cost*	*Timeframe*	*Control Efficiency*	*Indicators*
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	Approx R500 000 per Municipality	Short Term (2008)	Not Applicable	A comprehensive, electronic emissions inventory of all small industries in each Municipality
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
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
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

Table 60: Action plan for selected interventions identified for the Transportation Sector

TRANSPORTATION							
Intervention	*Implementation Strategy*	*Responsible*	*Assumptions*	*Estimated Cost*	*Timeframe*	*Control Efficiency*	*Indicators*
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
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
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 are in compliance within the required timeframes
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	Approx R 200 000 per intersection	Short Term	Unknown	Congestion is reduced during peak hours

Table 61: Action plan for selected interventions identified for Waste Burning

WASTE BURNING							
Intervention	*Implementation Strategy*	*Responsible*	*Assumptions*	*Estimated Cost*	*Timeframe*	*Control Efficiency*	*Indicators*
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	Approx R80 000	Short Term		A comprehensive, electronic emissions inventory of all waste burning sources in each Municipality
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
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
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

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Table 62: Action plan for selected interventions identified for the Government Sectors

GOVERNMENT CAPACITY							
Intervention	*Implementation Strategy*	*Responsible*	*Assumptions*	*Estimated Cost*	*Timeframe*	*Control Efficiency*	*Indicators*
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
Marketing of the Priority Area	DEAT to develop marketing campaigns using all forms of media (radio, newspapers, flyers etc.) This information is to be given to COJ, FDDM and SDM to disseminate to members of the public	DEAT	People have access to the information	Approx R1 000 000	Short Term (Jan 2008)		Public and politicians are aware of the significance of the Vaal Triangle Airshed Priority Area 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, modelling 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

Table 63: Action plan for selected interventions identified for Information Management

INFORMATION MANAGEMENT							
Intervention	*Implementation Strategy*	*Responsible*	*Assumptions*	*Estimated Cost*	*Timeframe*	*Control Efficiency*	*Indicators*
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
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
Comprehensive emissions inventory	An electronic, centralized emissions inventory database is developed as part of SAAQIS COJ, FDDM and SDM to submit their emissions inventories to DEAT *(COJ is in the process of updating their emissions inventory)*	DEAT and SAWS	COJ, FDDM and SDM have a comprehensive, electronic emissions inventory	R 2 million – R 4 million	Short Term (2008) and ongoing	80% control of Local Authorities emission inventories	All emissions inventories are collated into a centralised, electronic 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

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