Project Done on Behalf of
Sasol Technology (Pty) Ltd

Atmospheric Impact Report: Ekandustria

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Authors:

L Burger
R von Gruenewaldt
T Bird

Airshed Planning Professionals (Pty) Ltd

PO Box 5260
Halfway House
1685

Tel: +27 (11) 805 1940
Fax: +27 (11) 805 7010
e-mail: mail@airshed.co.za

Preface

Sasol's operations at the Sasol Nitro Ekandustria facility (Ekandustria) are required to comply with the Minimum Emissions Standards, which came into effect in terms of Section 21 of the National Environment Management: Air Quality Act (Act No 39 of 2004) on 1 April 2010. The Minimum Emissions Standards were subsequently amended and the amendments were promulgated on 22 November 2013 (Government Gazette No. 37054), replacing the 2010 regulations. These standards require the organic chemicals manufacturing facility to comply with standards for "existing plant" by 1 April 2015, and for "new plant" by 1 April 2020. Sasol intends submitting an application for postponement of the compliance timeframes of the Minimum Emissions Standards. In support of the submissions and to fulfil the requirements for these applications stipulated in the Air Quality Act and the Minimum Emissions Standards, an Atmospheric Impact Report (AIR) is required to substantiate the motivation for the postponement.

The pollutant of concern for this study is monomethylamine (MMA).

Airshed Planning Professionals (Pty) Ltd (hereafter referred to as Airshed) was appointed by Sasol to provide independent and competent services for the compilation of an Atmospheric Impact Report as set out in the October 2013 Regulations (Government Gazette No. 36904, Notice Number 747 of 2013) and detailing the results of the dispersion model runs. The tasks to be undertaken consist of:

1) Review of emissions inventory for the identified point sources and identification of any gaps in the emissions inventory. Where possible, it is preferable that gaps be estimated using an agreed emission estimation technique.
2) Prepare meteorological input files for use in dispersion models to cover the applicable Sasol sites. Sasol will provide surface meteorological data and ambient air quality data from the Sasol ambient air quality monitoring stations, which can be supplemented with other data as required.
3) Preparation of dispersion models set up with Sasol's emissions inventory capable of running various scenarios for each of the point sources as specified by Sasol, in conjunction with Sasol Technology's Research and Development department.
4) Airshed will validate the dispersion model based on an acceptable and agreed approach (provided there is sufficient measured ambient data available).
5) It was anticipated that each point source identified would require two scenarios per component per point source to be modelled, in order to establish the delta impacts against the DEA-approved baselines. i.e.:
    a. *Scenario 1 - Baseline Emissions*
        a) *With controls*: modelling of MMA based on the current routine inventory and impacts
        b) *With no controls:* modelling of MMA based on current inventory and impacts, when no emission controls in place (worst-case scenario)
    b. *Scenario 2 - Compliance Scenario* – modelling conducted based on compliance to the legislative requirement as stipulated within the Listed Activities and Minimum Emissions Standards for both existing plant and new plant standards (minimum emissions standards for MMA remain the same for existing and new plant standards)
6) Comparison of dispersion modelling results with the National Ambient Air Quality Standards (NAAQS).
7) A report detailing the methodology used and model setup.
8) Interactions with Environmental Assessment Practitioner (EAP) to provide all necessary inputs into the EAP's compilation of documentation in support of Sasol's postponement application. Airshed will attend all Public Participation meetings scheduled by the EAP to address any queries pertaining to the dispersion model.

The Atmospheric Impact Report (AIR) was prepared in alignment with the Regulations Regarding Air Dispersion Modelling, following a 'fit for purpose' code of practice (Section 1.2; Government Gazette No. 37804 vol. 589; 11 July 2014). This approach aimed to present sufficient and pertinent information to assist stakeholders to assess the impacts associated with Sasol's applications for postponement of MES compliance timeframes.

Updates made to the AIR following conclusion of the public comment period

The following types of updates have been made to this document following the conclusion of the public comment period:

- updates that address stakeholder comments or queries, or provide expanded explanations of key concepts;
- references to changes in regulations, for example the Regulations Regarding Air Dispersion Modelling which were promulgated in July 2014; and,
- update cross-references; for example between the AIR and the motivation report.

A detailed list of changes is provided in Table B-1.

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List of Abbreviations

AQA	Air quality act
DEA	Department of Environmental Affairs
g	Gram
g/s	Gram per second
LMo	Monin-Obukhov length
m	Meter
m²	Meter squared
m³	Meter cubed
m/s	Meters per second
MMA	Monomethylamine (part of the amine group of chemicals)
NAAQS	National ambient air quality standards
NEMAQA	National Environmental Management Air Quality Act
US EPA	United States Environmental Protection Agency
µg	micrograms
°C	Degrees Celsius

Glossary

Advection	Transport of pollutants by the wind
Airshed	An area, bounded by topographical features, within which airborne contaminants can be retained for an extended period
Algorithm	A mathematical process or set of rules used for calculation or problem-solving, which is usually undertaken by a computer
Assessment of environmental effects	A piece of expert advice submitted to regulators to support a claim that adverse effects will or will not occur as a result of an action, and usually developed in accordance with section 88 of the Resource Management Act 1991
Atmospheric chemistry	The chemical changes that gases and particulates undergo after they are discharged from a source
Atmospheric dispersion model	A mathematical representation of the physics governing the dispersion of pollutants in the atmosphere
Atmospheric stability	A measure of the propensity for vertical motion in the atmosphere
Building wakes	Strong turbulence and downward mixing caused by a negative pressure zone on the lee side of a building
Calm / stagnation	A period when wind speeds of less than 0.5 m/s persist
Cartesian grid	A co-ordinate system whose axes are straight lines intersecting at right angles
Causality	The relationship between cause and effect
Complex terrain	Terrain that contains features that cause deviations in direction and turbulence from larger-scale wind flows
Configuring a model	Setting the parameters within a model to perform the desired task
Convection	Vertical movement of air generated by surface heating
Convective boundary layer	The layer of the atmosphere containing convective air movements
Data assimilation	The use of observations to improve model results – commonly carried out in meteorological modelling
Default setting	The standard (sometimes recommended) operating value of a model parameter
Diagnostic wind model (DWM)	A model that extrapolates a limited amount of current wind data to a 3-D grid for the current time. It is the 'now' aspect, and makes the model 'diagnostic'.
Diffusion	Clean air mixing with contaminated air through the process of molecular motion. Diffusion is a very slow process compared to turbulent mixing.
Dispersion	The lowering of the concentration of pollutants by the combined processes of advection and diffusion
Dispersion coefficients	Variables that describe the lateral and vertical spread of a plume or a puff
Dry deposition	Removal of pollutants by deposition on the surface. Many different processes (including gravity) cause this effect.
Sasol Nitro	The entity now known as Sasol Chemical Industries (Pty) Limited operating through its Satellite Operations, formerly Sasol Nitro, a division of Sasol Chemical Industries (Pty) Limited. To avoid unnecessary confusion, the name "Sasol Nitro" has been retained in this report.

Atmospheric Impact Report

1 Enterprise Details

1.1 Enterprise Details

The details of Ekandustria operations are summarised in Table 1-1. The contact details of the responsible person, the emission control officer, are provided in Table 1-2.

Table 1-1: Enterprise details

Enterprise Name	Sasol Nitro (a division of Sasol Chemical Industries (Pty) Limited)
Trading as	Sasol Nitro Ekandustria
Type of Enterprise	Private company
Company Registration Number	1968-0013914-06
Registered Address	486 Brandbach Road, Ekandustria
Telephone Number (General)	013 933 6000
Fax Number (General)	013 933 3588
Industry Type/Nature of Trade	Manufacturing of explosives
Land Use Zoning as per Town Planning Scheme	Industrial
Land Use Rights if Outside Town Planning Scheme	

Table 1-2: Contact details of responsible person

Responsible Person	Mr Raymond Gibbison
Telephone Number	013 933 6000
Cell Number	+27 82 446 8445
Fax Number	+27 11 329 6858
Email Address	ray.gibbison@sasol.com
After Hours Contact Details	+27 82 446 8445

1.2 Location and Extent of the Plant

Table 1-3: Location and extent of the plant

Physical Address of the Plant	486 Brandbach Road, Ekandustria
Description of Site (Where no Street Address)	
Coordinates of Approximate Centre of Operations	E25° 40.983' S 28°41.080'
Extent	360 ha
Elevation Above Sea Level	1507 m
Province	Gauteng
Metropolitan/District Municipality	City of Tshwane Metropolitan Municipality
Local Municipality	Kungwini
Designated Priority Area	None

1.3 Atmospheric Emission Licence and other Authorisations

The following authorisations, permits and licences related to air quality management are applicable:

- Atmospheric Emission License:
    - 9/16/1/2/10/R issued by the City of Tshwane Metropolitan Municipality
- Other:
    - None

2 NATURE OF THE PROCESS

2.1 Listed Activities

A summary of listed activities currently undertaken at Ekandustria is provided in Table 2-1.

Table 2-1: Listed activities

Category of Listed Activity	Sub-category of the Listed Activity	Description of the Listed Activity
Category 4	Sub-category 4.13: Lead Smelting	The extraction, processing and use of lead in production by the application of heat. The production of lead containing electric batteries.
Category 6	Sub-Category 6.1: Organic Chemicals Industry	The production of organic chemicals
Category 8	Sub-Category 8.3: Burning Grounds	Facilities where waste material from the manufacture of explosives and contaminated explosive packaging material are destroyed

2.2 Process Description

Monomethylamine Nitrate (MMAN) is a sensitizer used in the production of explosives. It is manufactured by combining monomethylamine (MMA) with nitric acid. The combination of the two liquids is done in a reactor creating an exothermic reaction which forms MMAN and due the heat of the reaction the water contained in the nitric acid is boiled off. The steam from the reaction leaves the top of the reactor through a stack that enters a scrubber column. The MMAN formed is further processed and pumped to storage tanks.

Due to the violent boiling action in the reactor there are traces of MMAN and MMA entrained in the steam leaving the reactor. The steam enters the scrubber column from the base and flows up the scrubber column and exits through the scrubber stack. Flowing counter current to the steam is scrubber liquid at the correct pH which will react with any free MMA to form MMAN and the MMAN entrained in the steam will be scrubbed out by the liquid.

The MMAN is then used in downstream processes to produce a variety of explosives in non-listed activity processes. Lead is also used as part of the process to produce detonators.

All the off-specification lead-related products are processed in a lead furnace, where the lead is recovered for recycling.

Since the plant is an explosive manufacturing facility, the facility is required, through the Explosives Act, to destroy explosive contaminated waste on a Burning Ground. The burning ground consists of various areas where dedicated contaminated waste is burned. Access, and the type of waste taken to the burning ground, is controlled and burning normally takes place on a daily basis during daytime.

2.3 Unit Processes

Unit process considered listed activities under the National Environmental Management Air Quality Act (NEMAQA) are summarised in Table 2-2.

Table 2-2: List of unit processes considered listed activities under NEMAQA

Name of the Unit Process	Unit Process Function	Batch or Continuous Process
Neutraliser	Neutralisation	Continuous
Burning grounds	Destruction of waste materials	Batch
Lead furnace	Recovery of lead with heat	Batch

Burning grounds and lead furnace are not included in this AIR because Sasol Nitro will be able to comply with the regulations pertaining to these listed activities.

3 Technical Information

Based on trade secrets and intellectual property, this information cannot be made public. It can be viewed on site on request by the National Air Quality Officer or a duly authorized person.

3.1 Appliances and Abatement Equipment Control Technology relating to the postponement request

Table 4-1: Appliances and abatement equipment control technology relating to the postponement request

Appliance Name	Abatement Appliance Type	Appliance function / purpose
Neutraliser scrubber	Scrubber and condenser system	Absorbs the MMA in the flue gas and hence reduces the amount of emissions emitted.
Lead smelting furnace scrubber	Wet Scrubber	Condenses and scrubs any particles or lead emission from the melting pot

The purpose of the neutraliser scrubber and condenser system is to remove MMA from the stack gases which results in a liquid effluent stream containing MMA that must be routed to a waste water treatment facility.

4 ATMOSPHERIC EMISSIONS

The establishment of a comprehensive emission inventory for the listed activities seeking postponement formed the basis for the assessment of the air quality impacts from Ekandustria operations on the receiving environment.

4.1 Point Source Parameters

Table 4-1: Point source parameters

Point Source Number	Point Source Name	Point Source Coordinates	Height of Release above Ground (m)	Height above Nearby Building (m)	Diameter at Stack Tip or Vent Exit (m)	Actual Gas Exit Temperature (°C)	Actual Gas Volumetric Flow Rate (m^3/hr.)	Actual Gas Exit Velocity (m/s)	%O_2	Type of Emission (Continuous /Batch)
1	MMA Stack	S 25.68126° E 28.686318°	5.8	3	0.4	104	1 310	2.9		Continuous
2	Lead furnace stack	S 25.68278 ° E 28.68722 °	3.1	Stack is approximately 2 m lower than pitch of nearest building	0.21 x 0.21	33	1 860	15.6		Batch

4.2 Point Source Maximum Emission Rates during Normal Operating Conditions

Table 4-2: Point source emission rates during normal operating conditions

Point Source Number	Point Source Name	Pollutant Name	Maximum Release Rate during normal operation		
			Emission Concentration (mg/Nm^3)	Averaging Period	Duration of Emission
1	MMA stack	MMA	100	Hourly*	Batch
2	Lead furnace stack	Particulates	30	Hourly	Batch
		Lead	2	Hourly	Batch
*: Hourly values due to ad hoc sampling campaign resulting in the result being expressed as the average of 3 hourly meetings.					

Normal operating conditions include an operational condenser with sufficient waste water treatment capability to manage the effluent. During normal operating conditions the condenser may have to be switched off due to adverse weather conditions of high rainfall, hence this scenario was also modelled as the “no controls” Baseline Scenario.

Table 4-3: Point source emission rates without any process/abatement controls are in place conditions

Point Source Number	Point Source Name	Pollutant Name	Average Emission Rate		
			Emission Concentration (mg/Nm^3)	Averaging Period	Duration of Emission
1	MMA stack	MMA	4 020	Periodic measurements (annual average)	Continuous

4.3 Point Source Maximum Emission Rates during Start-up, Maintenance and/or Shut-down

Sasol Chemical industries’ Ekandustria Operations (SCI Ekandustria) only conducts periodic measurements which make it difficult to establish maximum emissions during start-up, shut-down, maintenance or upset conditions, since periodic measurements cannot pin-point exactly when the maximum will occur. The main reason maximum values cannot be predicted with periodic sampling, in this case, is that the sampling methods prescribes fixed time periods during which a sample must be taken. In addition, the timing of specific conditions leading to an absolute maximum emission rate is not predictable, meaning that the sampling period and the conditions resulting in the upsets are unlikely to occur concurrently; hence it cannot be guaranteed that a maximum emission rate will be reached at a specific condition.

4.4 Fugitive Emissions

SCI Ekandustria operates a burning ground to destroy waste contaminated with explosives. Combustion takes place between 09:00 and 15:00 on a daily basis.

A network of dustfall buckets, to monitoring dustfall rates, is in the process of installation to manage dust fallout, as per legislative requirements (National Dust Control Regulations; Government Gazette No. 36974, No. R. 827; 1 November 2013).

4.5 Emergency Incidents

There were no reportable emergency incidents relating to air quality in the relevant two year period (2012/2013).

Emergency incidents on the site are handled through standard operating procedures governing the actions that need to take place, as well as defining the responsibilities of the parties involved in managing the incident. Part of any environmental incident/emergency response, the environmental respondent will evaluate the incident and then classify it according to an internal ranking as well as against relevant legislative requirements which will then trigger the necessary reporting requirements.

5 Impact of Enterprise on the Receiving Environment

The report includes the results for two emission scenarios in order to establish the impacts on air quality. The scenarios are as follows:

- *Scenario 1 - Baseline Emissions*
  a) *With controls*: modelling of MMA based on the current routine inventory and impacts
  b) *With no controls:* modelling of MMA based on current inventory and impacts, when no emission controls in place (worst-case scenario)
- *Scenario 2 - Compliance Scenario* – modelling conducted based on plants complying with:
  - Existing and New Plant Emission Standards (Minimum Emissions Standards for MMA remain the same for existing and new plant standards)

5.1 Analysis of Emissions' Impact on Human Health

5.1.1 Study Methodology

5.1.1.1 Study Plan

The study methodology may conveniently be divided into a "preparatory phase" and an "execution phase". The basic methodology followed in this assessment is provided in Figure 5-1.

The preparatory phase included the following basic steps prior to performing the actual dispersion modelling and analyses:

1. Understand scope of work
2. Assign appropriate specialists
3. Review of legal requirements (e.g. dispersion modeling guideline)
4. Prepare a plan of study for peer-review
5. Decide on dispersion model

The Regulations Regarding Air Dispersion Modelling (Gazette No 37804, vol. 589; published 11 July 2014) was referenced for the dispersion model selection (Appendix B).

Three Levels of Assessment are defined in the Draft Regulations Regarding Air Dispersion Modelling:

- Level 1: where worst-case air quality impacts are assessed using simpler screening models
- Level 2: for assessment of air quality impacts as part of license application or amendment processes, where impacts are the greatest within a few kilometers downwind (less than 50km)
- Level 3: require more sophisticated dispersion models (and corresponding input data, resources and model operator expertise) in situation:
  - where a detailed understanding of air quality impacts, in time and space, is required;
  - where it is important to account for causality effects, calms, non-linear plume trajectories, spatial variations in turbulent mixing, multiple source types and chemical transformations;
  - when conducting permitting and/or environmental assessment process for large industrial developments that have considerable social, economic and environmental consequences;
  - when evaluating air quality management approaches involving multi-source, multi-sector contributions from permitted and non-permitted sources in an airshed; or,

- when assessing contaminants resulting from non-linear processes (e.g. deposition, ground-level O_3, particulate formation, visibility).

The assessment of impact as a result of MMA emissions from the Sasol Nitro Ekandustria facility was considered to fall within the scope of a Level 2 assessment.

The execution phase (i.e. dispersion modelling and analyses) firstly involves gathering specific information in relation to the emission source(s) and site(s) to be assessed. This includes:

- Source information: Emission rate, exit temperature, volume flow, exit velocity, etc.;
- Site information: Terrain information, land use data;
- Meteorological data: Wind speed, wind direction, temperature, cloud cover, mixing height;
- Receptor information: Locations using discrete receptors and/or gridded receptors.

The model uses this specific input data to run various algorithms to estimate the dispersion of pollutants between the source and receptor. The model output is in the form of predicted concentrations at the receptor. These predicted concentrations are compared with relevant health and nuisance screening levels.

The following steps were followed for the execution phase of the assessment:

- Decide on meteorological data input (Figure 5-1- AERMET).
- *Feedback to Project Team and revise where necessary*
- Review emissions inventory
- *Feedback to Project Team and revise where necessary*
- Decide on modelling domain and grid resolution (Figure 5-1– AERMOD)
- *Feedback to Project Team and revise where necessary*
- Prepare all dispersion model input files (Figure 5-1- AERMOD)
    - Meteorology
    - Source data
    - Receptor grid
- Review all modelling input data files and fix where necessary
- Simulate sources and calculate air concentration levels for regular grid locations for the following scenarios (Figure 5-1–Simulations):
    - Baseline emissions
    - Change Baseline sources to reflect “Existing Emission” and “New Emission” standards.
- Compare against health-effect screening levels
- *Present Results to Project Team*
- Preparation of draft AIR
- *Present AIR to Project Team*
- Preparation of final AIR
- Updates to AIR in order to address stakeholder comments.

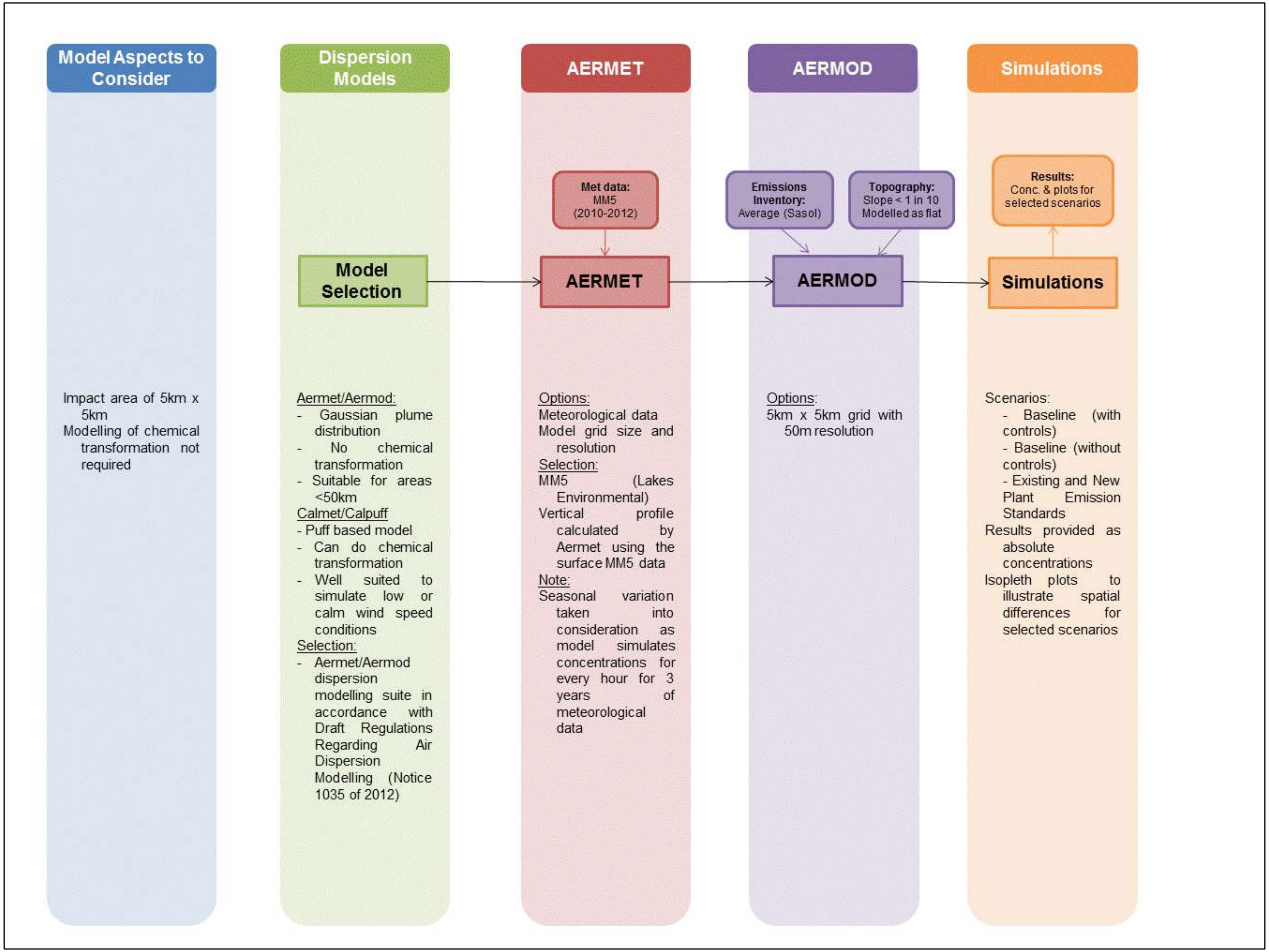

Figure 5-1: The basic study methodology followed for the assessment

5.1.1.2 AERMOD Modelling Suite

It was decided to employ the US Environmental Protection Agency's (US EPA) approved regulatory suite of models – AERMET/AERMOD. This model is based on a Gaussian plume model. AERMOD is a dispersion model, which was developed under the support of the AMS/EPA Regulatory Model Improvement Committee (AERMIC), whose objective has been to include state-of the-art science in regulatory models (Hanna *et al.,* 1999). The AERMOD is a dispersion modelling system with three components, namely: AERMOD (AERMIC Dispersion Model), AERMAP (AERMOD terrain pre-processor), and AERMET (AERMOD meteorological pre-processor).

- AERMET is a meteorological pre-processor for the AERMOD model. Input data can come from hourly cloud cover observations, surface meteorological observations and twice-a-day upper air soundings. Output includes surface meteorological observations and parameters and vertical profiles of several atmospheric parameters.

- AERMAP is a terrain pre-processor designed to simplify and standardize the input of terrain data for the AERMOD model. Input data includes receptor terrain elevation data. The terrain data may be in the form of digital terrain data. Output includes, for each receptor, location and height scale, which are elevations used for the computation of air flow around hills.

- AERMOD is an advanced new-generation model. It is designed to predict pollution concentrations from continuous point, flare, area, line, and volume sources. AERMOD offers new and potentially improved algorithms for plume rise and buoyancy, and the computation of vertical profiles of wind, turbulence and temperature however retains the single straight line trajectory limitation of ISCST3 (Hanna *et al.*, 1999).

Input data types required for the AERMOD model include: meteorological data, source data, and information on the nature of the receptor grid. Each of these data types will be described below.

5.1.1.2.1 Meteorological Requirements

AERMOD requires two specific input files generated by the AERMET pre-processor. AERMET is designed to be run as a three-stage processor and operates on three types of data (upper air data, on-site measurements, and the national meteorological database). A neighbouring industry operates a meteorological monitor in close proximity to the Ekandustria site. However, because of the limited data availability from this monitoring station, use was made of the modelled MM5 meteorological data for a point (25.681389°S; 28.686389°E) on-site for the period 2010 - 2012. MM5 is a widely-used three-dimensional numerical meteorological model which contains non-hydrostatic dynamics, a variety of physics options for parameterizing cumulus clouds, microphysics, the planetary boundary layer and atmospheric radiation. MM5 has the capability to perform Four Dimensional Data Assimilation (FDDA), and are able to simulate a variety of meteorological phenomena such as tropical cyclones, severe convective storms, sea-land breezes, and terrain forced flows such as mountain valley wind systems.

5.1.1.2.2 Topographical Data

The topography of the modelling domain around the Ekandustria site is generally flat with an average slope of 8.1%. The AERMOD Implementation Guide recommends that slopes less than 10% terrain be excluded from the dispersion model (US-EPA, 2009). On this basis, the flat terrain option was used in the AERMOD during the model runs.

5.1.1.2.3 Receptor Grid

The dispersion of pollutants was modelled for an area covering 5 km (north-south) by 5 km (east-west). This area was divided into a grid with a resolution of 50 m (north-south) by 50 m (east-west). AERMOD simulates ground-level concentrations for each of the receptor grid points.

5.1.2 Legal Requirements

5.1.2.1 Atmospheric Impact Report

In the event where an application for postponement is being made, Section 21 of NEM: Air Quality Act (AQA), Regulations 11 and 12 state:

1. An application for postponement may be made to the National Air Quality Officer
2 The application contemplated in Regulation 11 must include, amongst others, an Atmospheric Impact Report.

The format of the Atmospheric Impact Report is stipulated in the Regulations Prescribing the Format of the Atmospheric Impact Report, Government Gazette No. 36904, Notice Number 747 of 2013 (11 October 2013).

Sasol Nitro, Ekandustria, appointed Airshed to compile this AIR to meet the requirements of Regulation 12 (Postponement of compliance time frames) of the Listed Activities and Associated Minimum Emissions Standards (Government Gazette No. 437054, 22 November 2013).

5.1.3 Regulations Regarding Air Dispersion Modelling

Air dispersion modelling provides a cost-effective means for assessing the impact of air emission sources, the major focus of which is to determine compliance with the relevant ambient air quality standards. Regulations Regarding Air Dispersion Modelling were promulgated in Government Gazette No. 37804 vol. 589; 11 July 2014, and recommend a suite of dispersion models to be applied for regulatory practices as well as guidance on modelling input requirements, protocols and procedures to be followed. The Regulations Regarding Air Dispersion Modelling is applicable –

(a) in the development of an air quality management plan, as contemplated in Chapter 3 of the AQA;
(b) in the development of a priority area air quality management plan, as contemplated in section 19 of the AQA;
(c) in the development of an atmospheric impact report, as contemplated in section 30 of the AQA; and,
(d) in the development of a specialist air quality impact assessment study, as contemplated in Chapter 5 of the AQA.

The Regulations have been applied to the development of this report. The first step in the dispersion modelling exercise requires a clear objective of the modelling exercise and thereby gives clear direction to the choice of the dispersion model most suited for the purpose. Chapter 2 of the Regulations present the typical levels of assessments, technical summaries of the prescribed models (SCREEN3, AERSCREEN, AERMOD, SCIPUFF, and CALPUFF) and good practice steps to be taken for modelling applications.

Dispersion modelling provides a versatile means of assessing various emission options for the management of emissions from existing or proposed installations. Chapter 3 of the Guideline prescribes the source data input to be used in the models. Dispersion modelling can typically be used in the:

- Apportionment of individual sources for installations with multiple sources. In this way, the individual contribution of each source to the maximum ambient predicted concentration can be determined. This may be extended to the study of cumulative impact assessments where modelling can be used to model numerous installations and to investigate the impact of individual installations and sources on the maximum ambient pollutant concentrations.
- Analysis of ground level concentration changes as a result of different release conditions (e.g. by changing stack heights, diameters and operating conditions such as exit gas velocity and temperatures).
- Assessment of variable emissions as a result of process variations, start-up, shut-down or abnormal operations.
- Specification and planning of ambient air monitoring programmes which, in addition to the location of sensitive receptors, are often based on the prediction of air quality hotspots.

The above options can be used to determine the most cost-effective strategy for compliance with the NAAQS. Dispersion models are particularly useful under circumstances where the maximum ambient concentration approaches the ambient air quality limit value and provide a means for establishing the preferred combination of mitigation measures that may be required including:

- Stack height increases;
- Reduction in pollutant emissions through the use of air pollution control systems (APCS) or process variations;
- Switching from continuous to non-continuous process operations or from full to partial load.

Chapter 4 of the Regulations prescribe meteorological data input from onsite observations to simulated meteorological data. The chapter also gives information on how missing data and calm conditions are to be treated in modelling applications. Meteorology is fundamental for the dispersion of pollutants because it is the primary factor determining the diluting effect of the atmosphere. Therefore, it is important that meteorology is carefully considered when modelling.

New generation dispersion models, including models such as AERMOD and CALPUFF, simulate the dispersion process using planetary boundary layer (PBL) scaling theory. PBL depth and the dispersion of pollutants within this layer are influenced by specific surface characteristics such as surface roughness, albedo and the availability of surface moisture:

- Roughness length (z_o) is a measure of the aerodynamic roughness of a surface and is related to the height, shape and density of the surface as well as the wind speed.
- Albedo is a measure of the reflectivity of the Earth's surface. This parameter provides a measure of the amount of incident solar radiation that is absorbed by the Earth/atmosphere system. It is an important parameter since absorbed solar radiation is one of the driving forces for local, regional, and global atmospheric dynamics.
- The Bowen ratio provides measures of the availability of surface moisture injected into the atmosphere and is defined as the ratio of the vertical flux of sensible heat to latent heat, where sensible heat is the transfer of heat from the surface to the atmosphere via convection and latent heat is the transfer of heat required to evaporate liquid water from the surface to the atmosphere.

Topography is also an important geophysical parameter. The presence of terrain can lead to significantly higher ambient concentrations than would occur in the absence of the terrain feature. In particular, where there is a significant relative difference in elevation between the source and off-site receptors large ground level concentrations can result. Thus the accurate determination of terrain elevations in air dispersion models is very important.

The modelling domain would normally be decided on the expected zone of influence; the latter extent being defined by the predicted ground level concentrations from initial model runs. The modelling domain must include all areas where the ground level concentration is significant when compared to the air quality limit value (or other guideline). Air dispersion models require a receptor grid at which ground-level concentrations can be calculated. The receptor grid size should include the entire modelling domain to ensure that the maximum ground-level concentration is captured and the grid resolution (distance between grid points) sufficiently small to ensure that areas of maximum impact adequately covered. No receptors however should be located within the property line as health and safety legislation (rather than ambient air quality standards) is applicable within the site.

Chapter 5 provide general guidance on geophysical data, model domain and coordinates system required in dispersion modelling, whereas Chapter 6 elaborates more on these parameters as well as the inclusion of background air concentration data. The chapter also provides guidance on the treatment of NO_2 formation from oxides of nitrogen emissions, chemical transformation of sulfur dioxide into sulfates and deposition processes.

Chapter 7 of the Regulations outlines how the plan of study and modelling assessment reports are to be presented to authorities. A comparison of how this study met the requirements of the Regulations is provided in Appendix B.

5.1.4 Screening Criteria

Since NAAQS have not been specified for MMA, a toxicological review for MMA (Van Niekerk and Fourie, 2013) was consulted for screening levels for this non-criteria pollutant, and some of the key points are summarised here. The review found that although few studies are available regarding the toxicology and epidemiology of MMA, the reported health impacts as a result of acute exposure (at elevated concentrations) can include breathing difficulties, burning sensation, sore throat, headache and the accumulation of fluid in the lungs. At sub-chronic (14 days) exposure in a low concentration range, mild irritation of the nasal mucosa was recorded in a rat inhalation study (Kinney *et al.*, 1990, cited by Van Niekerk and Fourie, 2013). The findings from the Kinney *et al.* (1990) rat inhalation study, informed the US-EPA definition of a "no-observed-adverse-effect-level (NOAEL)" for MMA (17 000 $\mu g/m^3$). Applying an uncertainty factor of 10 for inter-species variation (NOAEL based on rat inhalation study) and factor 10 for intra-species sensitivity (individual human sensitivity to MMA), Van Niekerk and Fourie (2013) recommend a using 170 $\mu g/m^3$ averaged over 14-days as a health effect screening level for MMA.

The US-EPA (2008, cited in Van Niekerk and Fourie, 2013) defined the Level of Distinct Odour Awareness (LOA) concentration for MMA as 710 $\mu g/m^3$. The health effects of chronic exposure to MMA are not available. The available literature (International Agency for Research on Cancer (IARC online), USEPA (IRIS online) and SEPA (online) cited in Van Niekerk and Fourie, 2013), suggest that carcinogenic effects are unlikely as a result of exposure to normal background levels of MMA.

In this assessment, predicted hourly and daily ground-level concentrations were screened against the short-term health effect screening level (170 $\mu g/m^3$) and the LOA (710 $\mu g/m^3$). Additionally, the predicted daily ground-level concentrations were extrapolated to a 14-day estimate, in order to compare with the screening levels. The sub-chronic 14-day averages were calculated based on the following extrapolation formula:

$$C_x / C_p = \left(t_p / t_x \right)^n$$

Equation 1

where,

C_x and C_p= corresponding plume centreline concentrations

t_x and t_p = any two averaging times

n = extrapolation power

Some authors have suggested a single-value for n in the range of 0.16 to 0.25:

- Stewart, Gale, Crooks (Slade, 1969) n=0.2
- Hilst (Slade, 1968) n=0.25
- Wipperman (Slade, 1968) n=0.18
- Turner (1970) n=0.17-0.20
- Meade (Nonhebel, 1960) n=0.16

In this study a single-value of 0.2 for n was used.

5.1.5 Atmospheric Dispersion Potential

Meteorological mechanisms govern the dispersion, transformation, and eventual removal of pollutants from the atmosphere. The analysis of hourly average meteorological data is necessary to facilitate a comprehensive understanding of the dispersion potential of the site. The horizontal dispersion of pollution is largely a function of the wind field. The wind speed determines both the distance of downward transport and the rate of dilution of pollutants. For this assessment, MM5 modelled meteorological data for a point on the Ekandustria site, for the period 2010 to 2012 (3 years), was used.

5.1.5.1 Surface Wind Field

Wind roses comprise 16 spokes, which represent the directions from which winds blew during a specific period. The colours used in the wind roses below, reflect the different categories of wind speeds; the red area, for example, representing winds >6 m/s. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories. The frequency with which calms occurred, i.e. periods during which the wind speed was below 1 m/s are also indicated.

The period wind field and diurnal variability for Ekandustria are provided in Figure 5-2. The predominant wind direction at Ekandustria for the period 2010-2012 is from the northeast. Day-time winds are usually from the northern sector (north-west and north-east); however, and night-time wind fields show a stronger predominance from the easterly sector (north-easterly and south-easterly). It should be noted that relatively low wind speeds and very little wind from the south western sector.

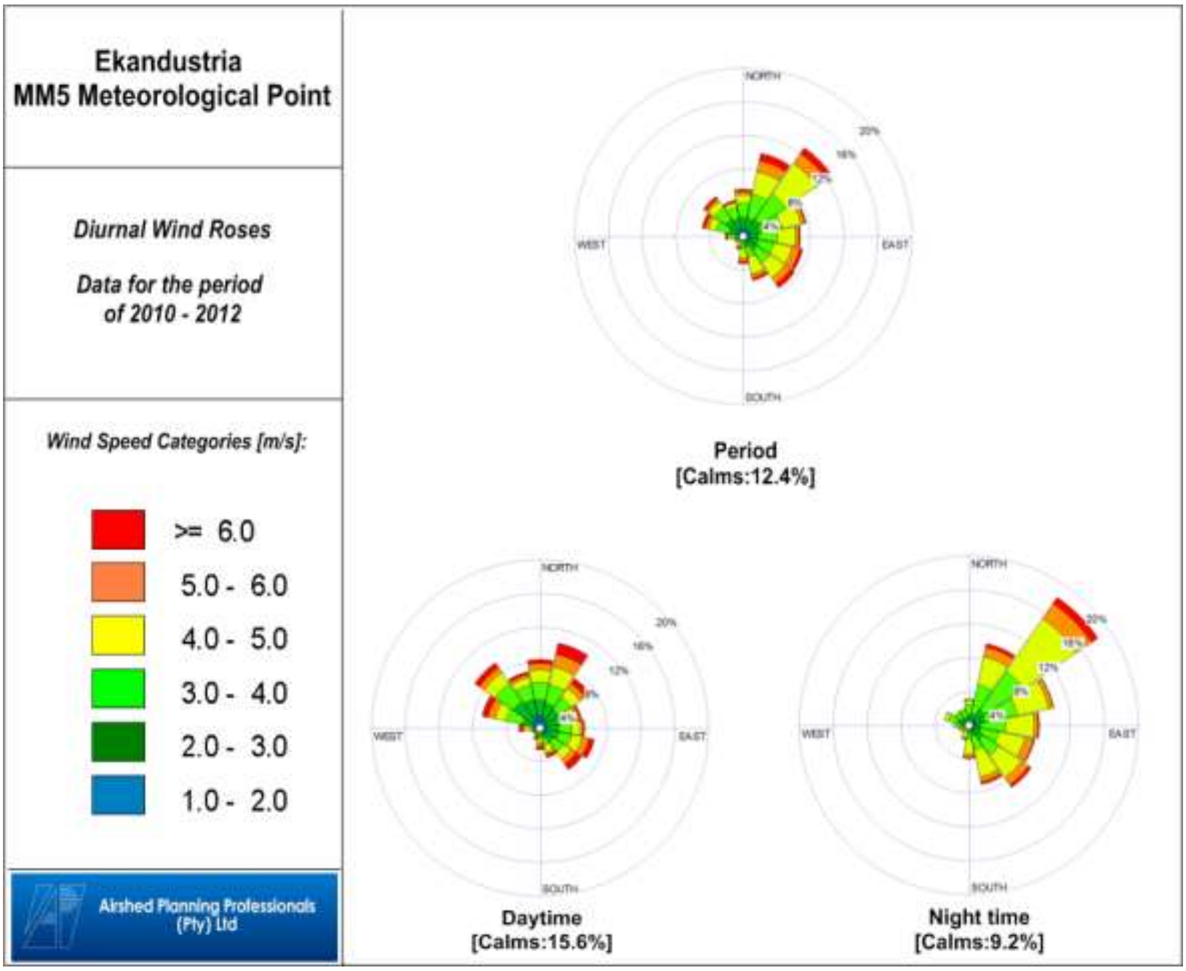

Figure 5-2: Period, day- and night-time wind roses for the Ekandustria MM5 point for the period 2010 -2012

5.1.5.2 Temperature

Air temperature is important, both for determining the effect of plume buoyancy (the larger the temperature difference between the emission plume and the ambient air, the higher the plume is able to rise), and determining the development of the mixing and inversion layers.

The average monthly temperature trends are presented in Figure 5-3 for Ekandustria. Monthly mean and hourly maximum and minimum temperatures are given in Table 5-1. Average temperatures ranged between 8.9 °C and 21.3 °C. The highest temperatures occurred in February and the lowest in July. During the day, temperatures increase to reach maximum at around 15:00 in the afternoon. Ambient air temperature decreases to reach a minimum at around 06:00 i.e. near sunrise.

Table 5-1: Monthly temperature summary (2010 - 2012) based on MM5 data

Hourly Minimum, Hourly Maximum and Monthly Average Temperatures (°C) (2010 - 2012)												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ekandustria												
Minimum	12.5	11.5	11.0	6.5	2.3	-1.5	0.6	-0.4	6.1	5.1	7.5	12.1
Maximum	30.6	31.8	29.5	25.4	24.1	18.8	18.5	23.8	24.6	31.1	30.5	29.9
Average	21.3	21.0	20.1	15.7	13.3	9.0	8.9	12.0	15.5	18.3	20.4	21.0

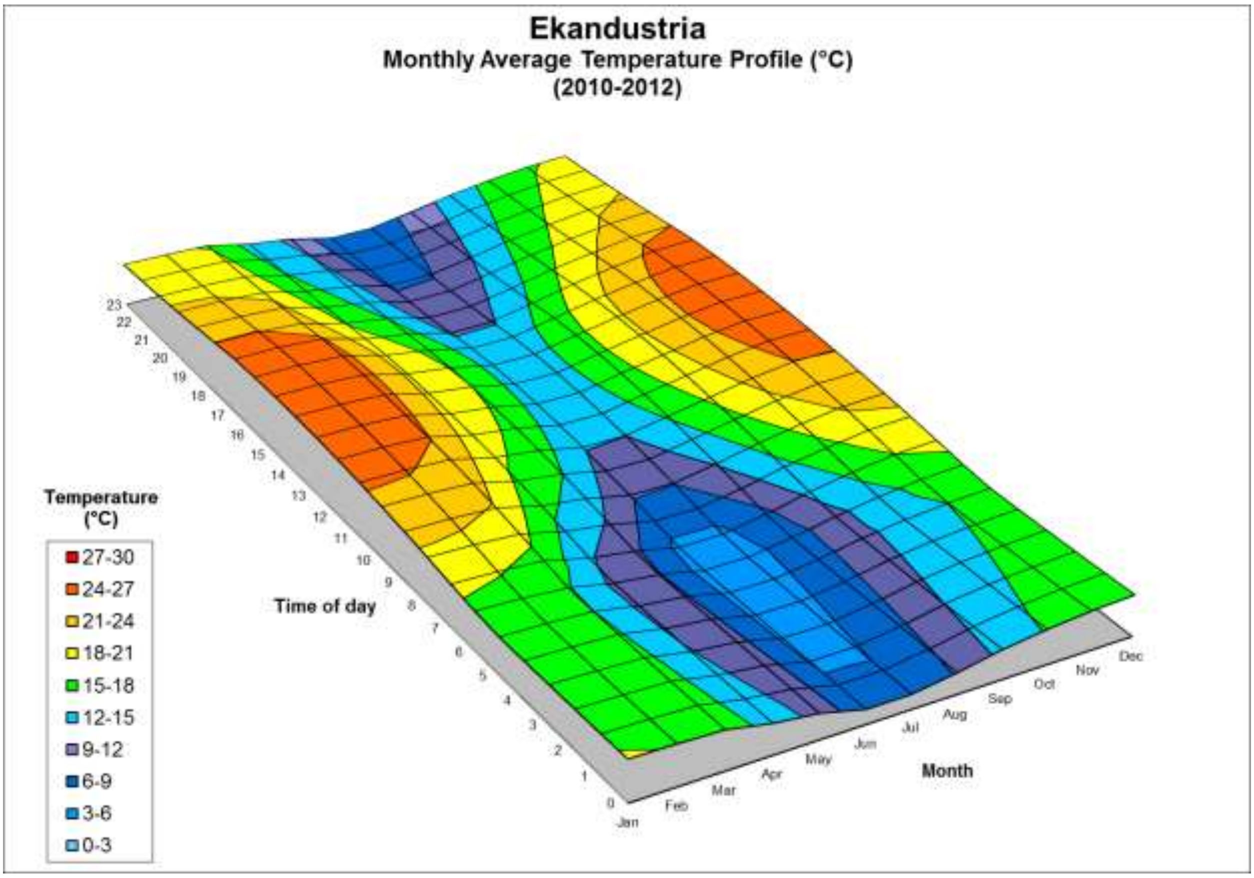

Figure 5-3: Monthly average temperature profile for Ekandustria (2010 - 2012)

5.1.5.3 Atmospheric Stability

The atmospheric boundary layer properties are described by two parameters; the boundary layer depth and the Monin-Obukhov length.

The Monin-Obukhov length (LMo) provides a measure of the importance of buoyancy generated by the heating of the ground and mechanical mixing generated by the frictional effect of the earth's surface. Physically, it can be thought of as representing the depth of the boundary layer within which mechanical mixing is the dominant form of turbulence generation (CERC, 2004). The atmospheric boundary layer constitutes the first few hundred metres of the atmosphere. During daytime, the atmospheric boundary layer is characterised by thermal turbulence due to the heating of the earth's surface. Night-times are characterised by weak vertical mixing and the predominance of a stable layer. These conditions are normally associated with low wind speeds and lower dilution potential.

Diurnal variation in atmospheric stability, as calculated from on-site data, and described by the inverse Monin-Obukhov length and the boundary layer depth is provided in Figure 5-4. The highest concentrations for ground level, or near-ground level releases from non-wind dependent sources would occur during weak wind speeds and stable (night-time) atmospheric conditions.

For elevated releases, unstable conditions can result in very high concentrations of poorly diluted emissions close to the stack. This is called looping (Figure 5-4(c)) and occurs mostly during daytime hours. Neutral conditions disperse the plume fairly equally in both the vertical and horizontal planes and the plume shape is referred to as coning (Figure 5-4 (b)). Stable conditions prevent the plume from mixing vertically, although it can still spread horizontally and is called fanning (Figure 5-4 (a)) (Tiwary & Colls, 2010).

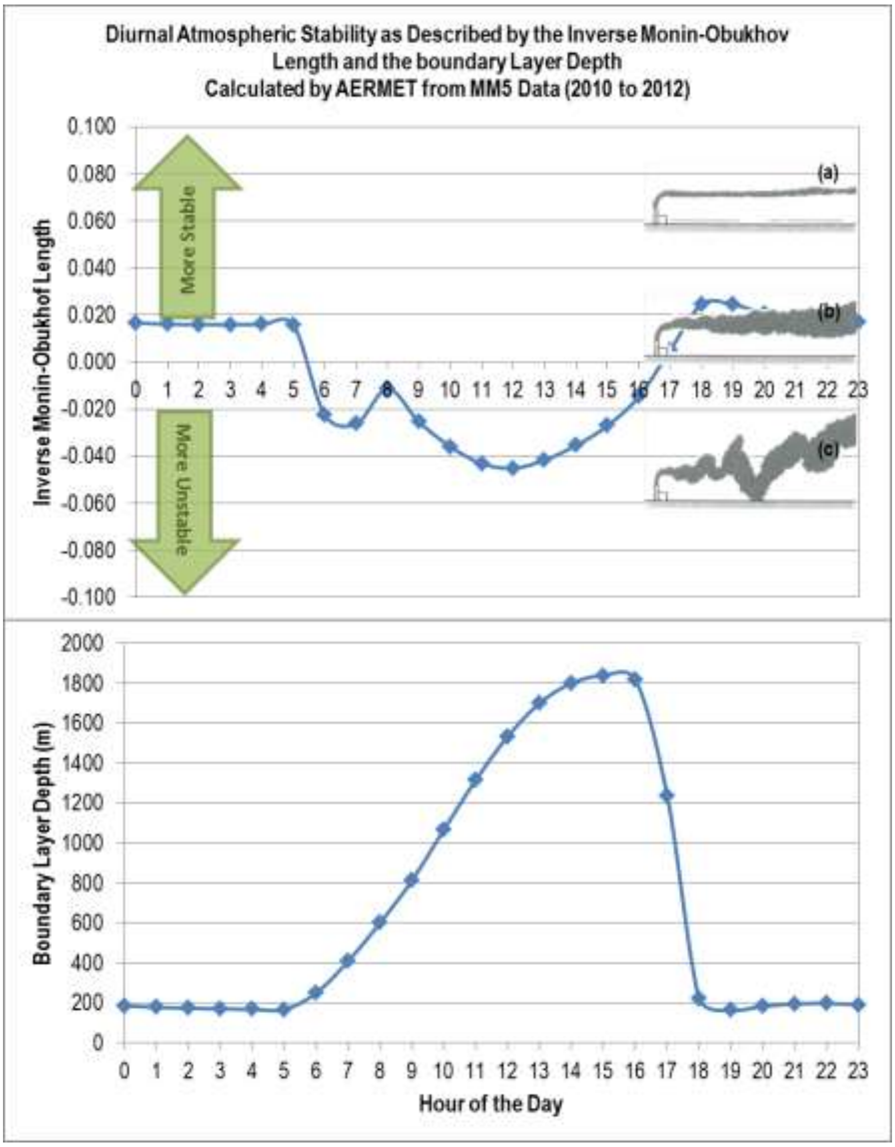

Figure 5-4: Diurnal atmospheric stability (extracted from MM5 data)

5.1.6 Plume Buoyancy

Gases leaving a stack mix with ambient air and undergo three phases namely the initial phase, the transition phase and the diffusion phase (Figure 5-5). The initial phase is greatly determined by the physical properties of the emitted gases. These gases may have momentum as they enter the atmosphere and are often heated and are therefore warmer than the ambient air. Warmer gases are less dense than the ambient air and are therefore buoyant. A combination of the gases' momentum and buoyancy causes the gases to rise (vertical jet section, in Figure 5-5). In the Bent-Over Jet Section, entrainment of the cross flow is rapid because by this time appreciable growth of vortices has taken place. The self-generated turbulence causes mixing and determines the growth of plume in the thermal Section. This is referred to as plume rise and allows air pollutants emitted in this gas stream to be lofted higher in the atmosphere. Since the plume is higher in the atmosphere and at a further distance from the ground, the plume will disperse more before it reaches ground level. With greater volumetric flow and increased exit gas temperatures, the plume centreline would be higher than if either the volumetric flow or the exit gas temperature is reduced. The subsequent ground level concentrations would therefore be lower.

This is particularly important in understanding the dispersion model results in Section 5.1.3.

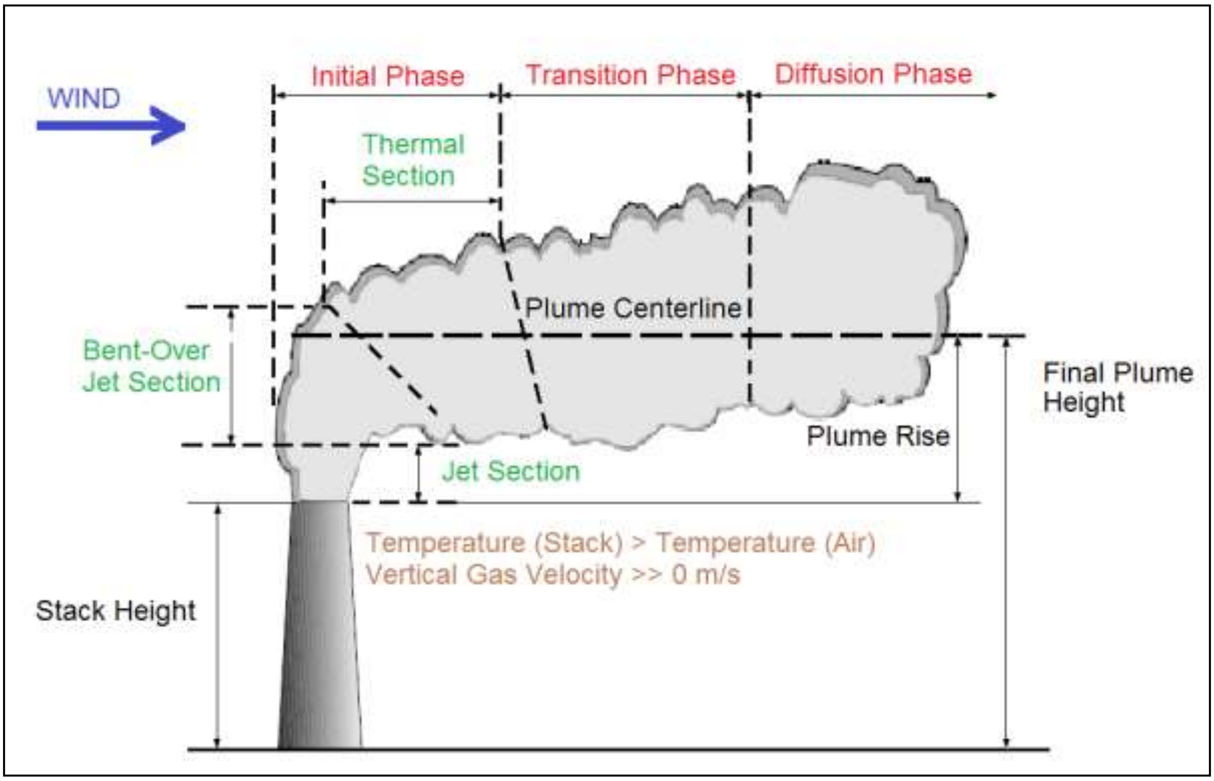

Figure 5-5: Plume buoyancy

5.1.7 Scenario Emission Inventory

The source parameters and emissions per scenario were provided by Sasol for the assessment (Table 5-2). A theoretical scenario during which the abatement equipment is not functional and the process controls that limit MMA emissions simultaneously fail to operate as intended was considered to be the worst-case scenario.

Table 5-2: Source parameters per scenario provided for Sasol Nitro, Ekandustria

Source name	Latitude (decimal degrees)	Longitude (decimal degrees)	Height of Release Above Ground (m)	Diameter at Stack Tip / Vent Exit (m)	Actual Gas Exit Temperature (°C)	Actual Gas Exit Velocity (m/s)	MMA Emission rate (g/s)
Scenario 1a - Baseline emissions with controls							
Main Stack (with controls in place)	25.68126°S	28.686318°E	5.8	0.4	104	2.9	0.00036
Scenario 1b – Baseline emissions without controls							
Main Stack (with no emission controls in place)	25.68126°S	28.686318°E	5.8	0.4	104	2.9	0.95000
Scenario 2 – Compliance with Existing Plant Standards*							
Main Stack	25.68126°S	28.686318°E	5.8	0.4	104	2.9	0.00224

* Minimum Emissions Standards for Existing and New Plants are equivalent

5.1.8 Model Results

5.1.8.1 Modelling domain and sensitive receptors

Prior to dispersion modelling, a 5-by-5 km modelling domain was defined. The dispersion modelling had no discrete receptors included. In response to stakeholder comments, schools and clinics within the domain were identified in the vicinity of the modelling domain and are indicated in the sensitive receptor map (Figure 5-6). The receptors fall out-side of the modelling domain and as such are not indicated on the isopleth plots (Section 5.1.8.2).

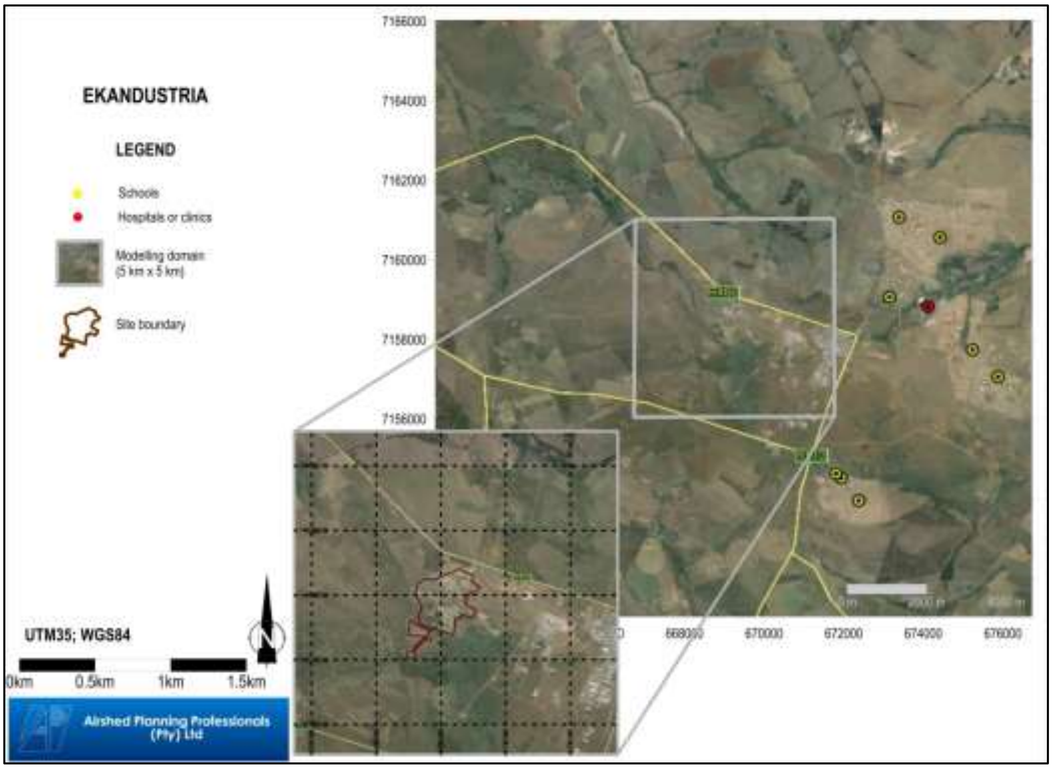

Figure 5-6: Ekandustria sensitive receptor and modelling domain map

5.1.8.2 *Dispersion modelling results*

Second highest hourly, daily and 14-day average ground-level concentrations of MMA were predicted to fall below the health effect screening level and LOA (odour detection limit) off-site (Table 5-3). The worst-case scenario (Baseline – no emission controls) resulted in the highest ground-level concentrations. Although the predicted hourly average concentration exceeds the health-effect screening level, the 170 µg/m³ level is recommended for sub-chronic exposure; the daily and 14-day averages are significantly below this level.

Table 5-3: Predicted second highest off-site ground-level MMA concentrations as a result of emissions from Sasol Nitro, Ekandustria (screening levels: 710 µg/m³ for hourly averages and 170 µg/m³ for 14-day averages)

Scenario	Second highest off-site ground level concentrations (µg/m³)		
	Hourly average	Daily average	14-day average
1a. Baseline – with emission controls	0.11	0.026	0.015
1b. Baseline – with no emission controls	295.00	70.00	41.30
2. Existing Plant Emission Standards	0.67	0.160	0.094

Isopleth plots were generated for hourly, daily and 14-day averages for the worst-case scenario, to show the extent of impact (Figure 5-7, Figure 5-8 and Figure 5-9).

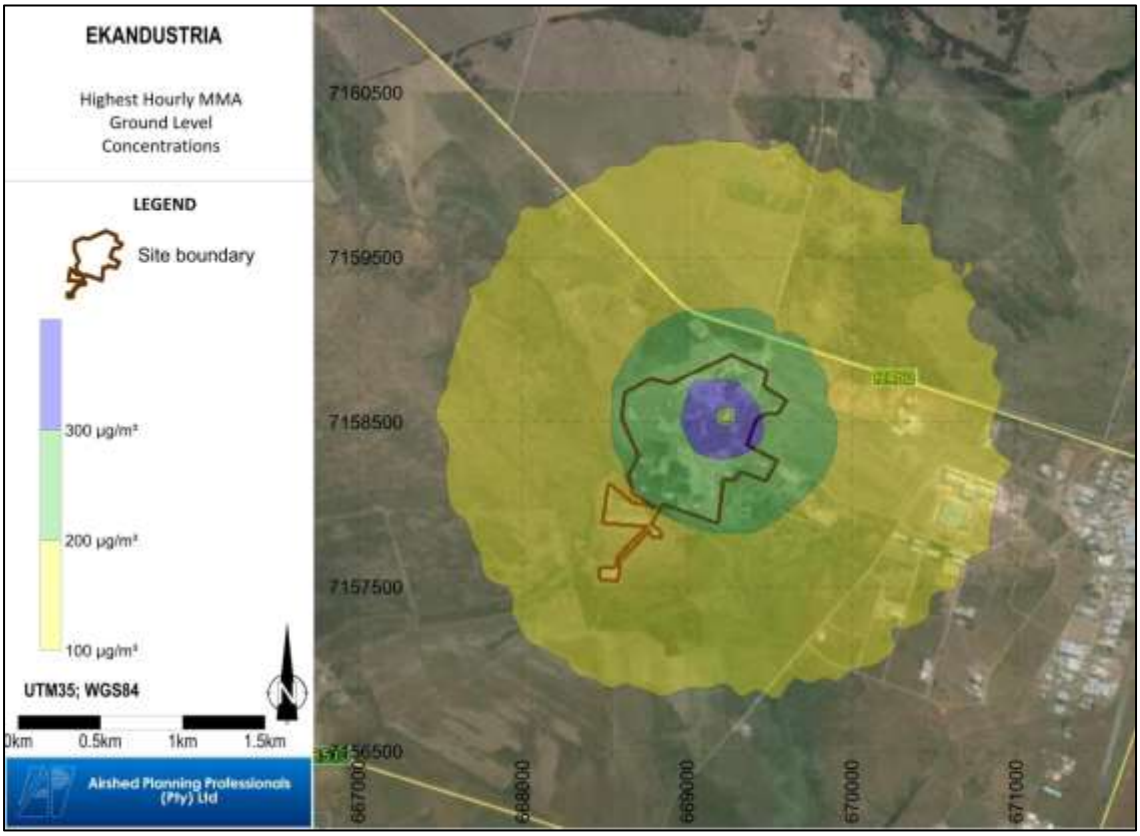

Figure 5-7: Predicted second highest hourly MMA ground-level concentrations for the worst-case scenario (screening level 710 µg/m³) (maximum predicted concentration: 440.6 µg/m³)

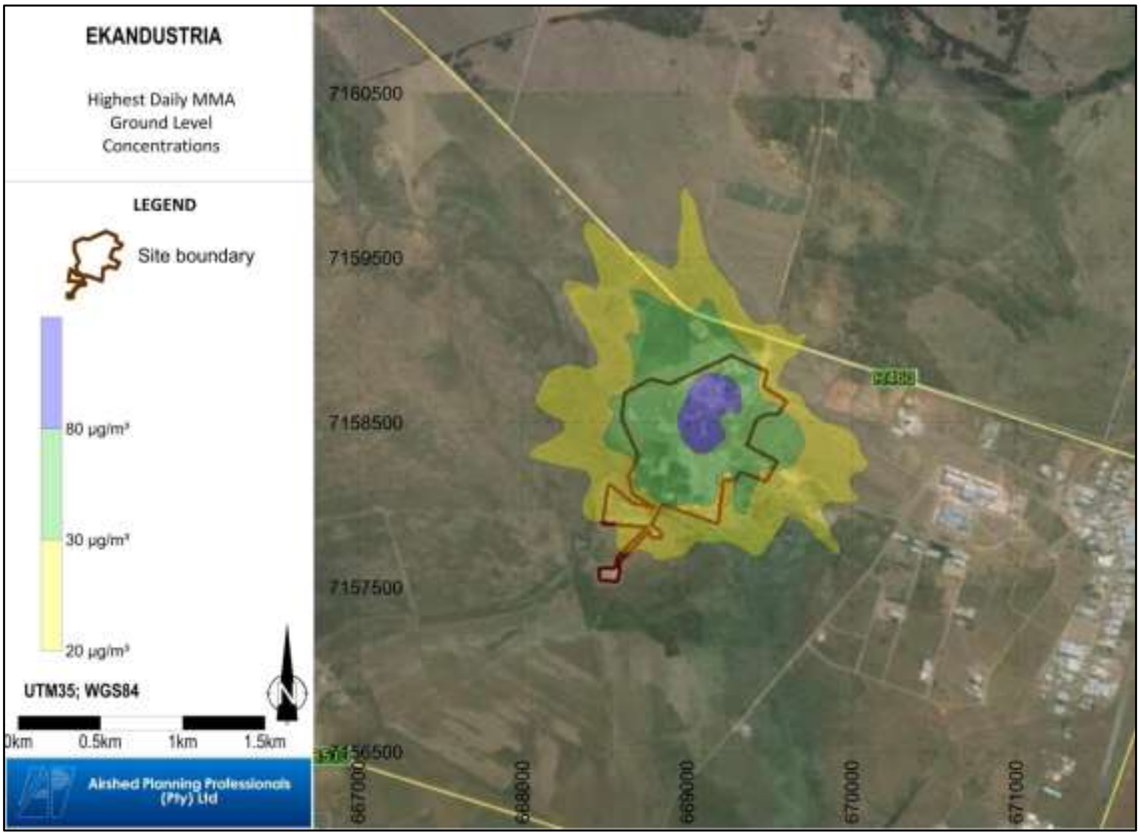

Figure 5-8: Predicted second highest daily MMA ground-level concentrations for the worst-case scenario (maximum predicted concentrations: 191.0 µg/m³)

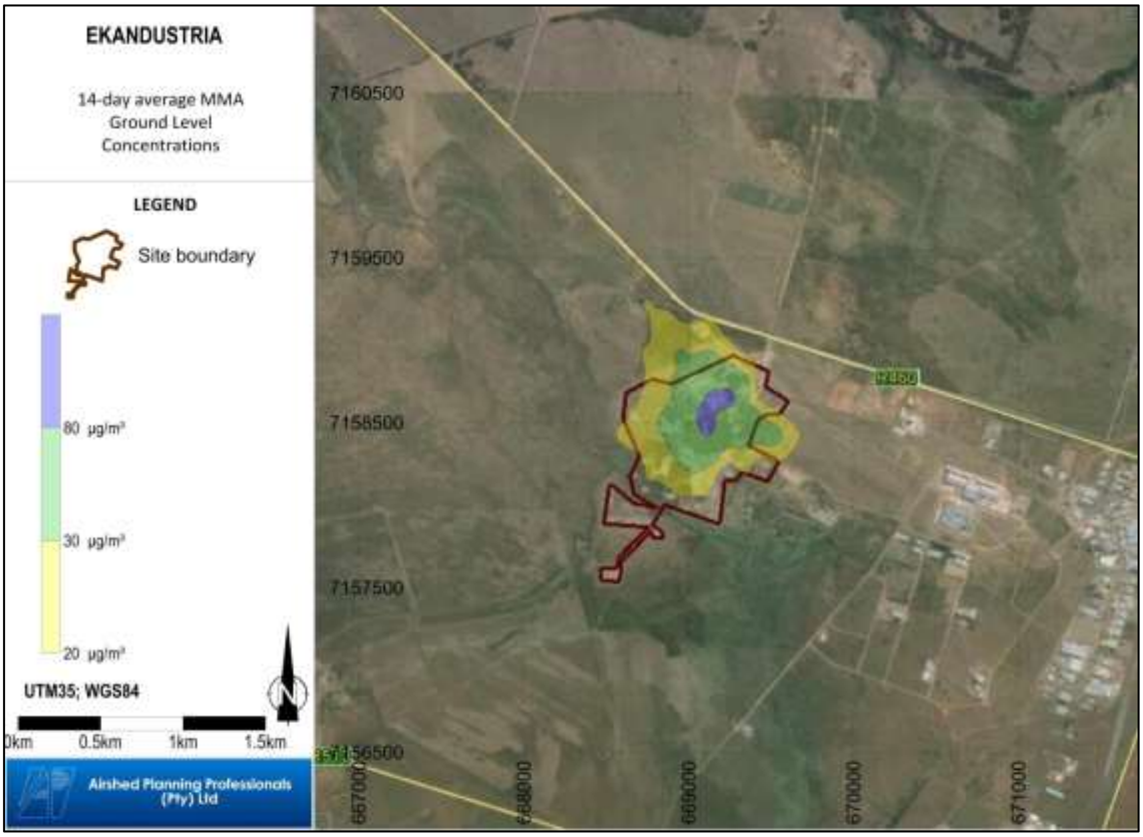

Figure 5-9: Predicted 14-day MMA ground-level concentrations for the worst-case scenario (screening level 170 µg/m³) (maximum predicted concentrations: 115 µg/m³)

5.1.9 Uncertainty of Modelled Results

There will always be some error in any geophysical model; however, modelling is recognised as a credible method for evaluating impacts, but it is desirable to structure the model in such a way to minimise the total error. A model represents the most likely outcome of an ensemble of experimental results. The total uncertainty can be thought of as the sum of three components: the uncertainty due to errors in the model physics; the uncertainty due to data errors; and the uncertainty due to stochastic processes (turbulence) in the atmosphere.

The stochastic uncertainty includes all errors or uncertainties in data such as source variability, observed concentrations, and meteorological data. Even if the field instrument accuracy is excellent, there can still be large uncertainties due to unrepresentative placement of the instrument (or taking of a sample for analysis). Model evaluation studies suggest that the data input error term is often a major contributor to total uncertainty. Even in the best tracer studies, the source emissions are known only with an accuracy of ±5%, which translates directly into a minimum error of that magnitude in the model predictions. It is also well known that wind direction errors are the major cause of poor agreement, especially for relatively short-term predictions (minutes to hourly) and long downwind distances. All of the above factors contribute to the inaccuracies not even associated with the mathematical models themselves.

Similar to the ISC model, a disadvantage of the model is that spatial varying wind fields, due to topography or other factors cannot be included. Although the model has been shown to be an improvement on the ISC model, especially short-term predictions, the range of uncertainty of the model predictions is -50% to 200%. The accuracy improves with fairly strong wind speeds and during neutral atmospheric conditions.

In quantifying the uncertainty of the modelled results for this assessment, measured ambient data is required which was not available for this study.

5.2 Analysis of Emissions' Impact on the Environment

The toxicological profile of MMA does not suggest that it would adversely affect soil, water and receptors other than human. A study of its impacts in this regard was therefore not considered necessary.

6 COMPLAINTS

Sasol Nitro, Ekandustria maintains a complaints register at its premises. Any complaints received by the facility are recorded in this register. In terms of regulation 6 of the Atmospheric Impact Report Regulations (Government Gazette No. 36904, Notice Number 747 of 11 October 2013) no complaints were received in respect of air pollution in the last two years for Sasol Nitro, Ekandustria.

7 RECOMMENDED AIR QUALITY MANAGEMENT INTERVENTIONS

The operation of process controls and a condenser system reduces the MMA emissions to below the Minimum Emissions Standard for existing and new plants. In order to operate the condenser during high rainfall periods, a new waste water treatment facility is required to treat the effluent from the system, in consideration of integrated environmental management principles. Sasol Nitro has initiated a project to implement a new water treatment facility, which is planned to be fully operational by 1 April 2020 at the latest. Further details are available in the Sasol Nitro motivation report which provides reasons for the postponement request.

8 COMPLIANCE AND ENFORCEMENT ACTIONS

No directives or compliance notices have been issued to Sasol Nitro, Ekandustria in the last five years.

9 ADDITIONAL INFORMATION

a) Toxicological review for methyl amine

Sasol has made application for postponement for certain non-criteria pollutants where NAAQS have not been set. In order to assess the ambient impacts of Sasol's emissions in these cases, benchmark limits were identified from literature reviews of peer-reviewed studies available internationally. In the case of Sasol Nitro – Ekandustria, the non-criteria pollutant for which benchmarks were identified, was MMA. A summary of the screening levels used to assess non-criteria pollutants is provided in Section 5.1.4 of the AIR and in Section 5.2 of the motivation report.

It is believed that Sasol is the dominant contributor of MMA to ambient concentrations, and as such Sasol commissioned an independent toxicologist to conduct a detailed desktop study of suitable health benchmarks for use in the AIR. The toxicological review is included as Annexure C to the postponement application.

10 ANNEXURE A(I)

ANNEXURE A

DECLARATION OF ACCURACY OF INFORMATION - APPLICANT

Name of Enterprise: SASOL NITRO EKANDUSTRIA

Declaration of accuracy of information provided:

Atmospheric Impact Report in terms of section 30 of the Act.

I, Lance Cullinan [*duly authorised*], declare that the information provided in this atmospheric impact report is, to the best of my knowledge, in all respects factually true and correct. I am aware that the supply of false or misleading information to an air quality officer is a criminal offence in terms of section 51(1)(g) of this Act.

Signed at Ekandustria on this 10 day of April 2014

SIGNATURE

Operations Manager

CAPACITY OF SIGNATORY

11 ANNEXURE A(II)

11 ANNEXURE A(II)

DECLARATION OF ACCURACY OF INFORMATION – APPLICANT

Name of Enterprise: Satellite Operations Ekandustria

Declaration of accuracy of information provided:

Atmospheric Impact Report in terms of section 30 of the Act.

I, Jan de Klerk *[duly authorised]*, declare that all additional information provided in this atmospheric impact report is, to the best of my knowledge, in all respects factually true and correct. I am aware that the supply of false or misleading information to an air quality officer is a criminal offence in terms of section 51(1)(g) of this Act.

Signed at Ekandustria on this 19 day of September 2014

SIGNATURE

Senior Manager Production
CAPACITY OF SIGNATORY

12 ANNEXURE B(I)

DECLARATION OF INDEPENDENCE - PRACTITIONER

Name of Practitioner:_Reneé von Gruenewaldt

Name of Registration Body: South African Council for Natural Scientific Professions

Professional Registration No.: 400304/07

Declaration of independence and accuracy of information provided:

Atmospheric Impact Report in terms of section 30 of the Act.

I, Reneé von Gruenewaldt, declare that I am independent of the applicant. I have the necessary expertise to conduct the assessments required for the report and will perform the work relating the application in an objective manner, even if this results in views and findings that are not favourable to the applicant. I will disclose to the applicant and the air quality officer all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the air quality officer. The information provided in this atmospheric impact report is, to the best of my knowledge, in all respects factually true and correct. I am aware that the supply of false or misleading information to an air quality officer is a criminal offence in terms of section 51(1)(g) of this Act.

Signed at Midrand on this 28 day of March 2014

SIGNATURE

Principal Air Quality Scientist

CAPACITY OF SIGNATORY

13 ANNEXURE B(II)

DECLARATION OF INDEPENDENCE - PRACTITIONER

Name of Practitioner:_Reneé von Gruenewaldt

Name of Registration Body: South African Council for Natural Scientific Professions

Professional Registration No.: 400304/07

Declaration of independence and accuracy of information provided:

Atmospheric Impact Report in terms of section 30 of the Act.

I, Reneé von Gruenewaldt, declare that I am independent of the applicant. I have the necessary expertise to conduct the assessments required for the report and will perform the work relating the application in an objective manner, even if this results in views and findings that are not favourable to the applicant. I will disclose to the applicant and the air quality officer all material information in my possession that reasonably has or may have the potential of influencing any decision to be taken with respect to the application by the air quality officer. The additional information provided in this atmospheric impact report is, to the best of my knowledge, in all respects factually true and correct. I am aware that the supply of false or misleading information to an air quality officer is a criminal offence in terms of section 51(1)(g) of this Act.

Signed at Midrand on this 22nd day of September 2014

SIGNATURE

Principal Air Quality Scientist

CAPACITY OF SIGNATORY

14 REFERENCES

CERC. (2004). *ADMS Urban Training. Version 2. Unit A.*

Hanna S. R., Egan B. A. Purdum J. and Wagler J. (1999) *Evaluation of the ADMS, AERMOD, and ISC3 Dispersion Models with the Optex, Duke Forest, Kincaid, Indianapolis, and Lovett Field Data Sets,* International Journal of Environment and Pollution (Volume 16, Nos. 1-6, 2001).

Nonhebel, G. (1960) Recommendations on heights for new industrial chimneys. *Journal of the Institute of Fuel, 33*: 479

Slade, D.H. (editor) (1968) *Meteorology and atmoic energy 1968*. Air Reources Laboratories ESSA, for USAEC Division of Technical Information, Silver Spring, Maryland. 445pp. doi:10.2172/4492043

Tiwary, A., and Colls, J. (2010). *Air pollution: measurement, monitoring and mitigation* (3rd Edition ed.). Oxon: Routledge.

Turner, D.B. (1970) *Workbook of Atmospheric Dispersion Estimates*. Public Health Services Publication No. 999-AP-26, U.S. Department of Health, Education, and Welfare, Cincinnati, Ohio. 84pp.

US EPA (2005). Revision to the Guideline on Air Quality Models: Adoption of a Preferred General Purpose (Flat and Complex Terrain) Dispersion Model and Other Revisions. North Carolina, U.S. Environmental Protection Agency, 2005. Federal Register / Vol. 70, No. 216 / Rules and Regulations. Appendix W of 40 CRF Part 51.

U.S. Environmental Protection Agency, (2009) *AERMOD Implementation Guide*, Revision 2009. US-EPA, Office of Air Quality Planning and Standards, Air Quality Assessment Division, Research Triangle Park, North Carolina.

Van Niekerk, W.C.A. and Fourie, M.H. (2013) *Toxicological review for monomethylamine*. Report to SASOL Group Services (Pty) Ltd. Document No 042-2013 Rev 1.0.

APPENDIX A: Competencies for Performing Air Dispersion Modelling

All modelling tasks were performed by competent personnel. Table A-1 is a summary of competency requirements. Apart from the necessary technical skills required for the calculations, personnel competency also include the correct attitude, behaviour, motive and other personal characteristic that are essential to perform the assigned job on time and with the required diligence as deemed necessary for the successful completion of the project.

The project team included two principal engineers, both with relevant experience of more than 25 years each and one principal scientist with 12 years relevant experience. One of the principal scientists managed and directed the project.

Verification of modelling results was also conducted by one of the principal engineers. The latter function requires a thorough knowledge of the

- meteorological parameters that influence the atmospheric dispersion processes and
- atmospheric chemical transformations that some pollutants may undergo during the dispersion process.

In addition, the project team included one senior and one junior staff member.

Table A-1: Competencies for Performing Air Dispersion Modelling

Competency	Task, Knowledge and Experience
Context	Communication with field workers, technicians, laboratories, engineers and scientists and project managers during the process is important to the success of the model
	Familiar with terminology, principles and interactions
	Record keeping is important to support the accountability of the model - Understanding of data collection methods and technologies
Knowledge	Meteorology: • Obtain, review and interpret meteorological data • Understanding of meteorological impacts on pollutants • Ability to identify and describe soil, water, drainage and terrain conditions o Understanding of their interaction o Familiarity with surface roughness` • Ability to identify good and bad data points/sets • Understanding of how to deal with incomplete/missing meteorological data
	Atmospheric Dispersion models • Select appropriate dispersion model • Prepare and execute dispersion model • Understanding of model input parameters • Interpret results of model
	Chemical and physical interactions of atmospheric pollutants • Familiarity with fate and transport of pollutants in air • Interaction of primary pollutants with other substances (natural or industrial) to form secondary pollutants
	Information relevant to the model • Identify potential pollution (emission) sources and rates • Gather physical information on sources such as location, stack height and diameter • Gather operating information on sources such as mass flow rates, stack top temperature, velocity or volumetric flow rate • Calculate emission rates based on collected information • Identify land use (urban/rural) • Identify land cover/terrain characteristics • Identify the receptor grid/site

Competency	Task, Knowledge and Experience
	Legislation, regulations and guidelines in regards to National Environment Management: Air Quality Act (Act No 39 of 2004), including • Minimum Emissions Standards (Section 21 of Act) • National Ambient Air Quality Standards • Regulations Regarding Air Dispersion Modelling • Atmospheric Impact Report (AIR)
Abilities	Ability to read and understand map information
	Ability to prepare reports and documents as necessary
	Ability to review reports to ensure accuracy, clarity and completeness
	Communication skills
	Team skills

APPENDIX B: Comparison of Study Approach with the Regulations Prescribing The Format Of The Atmospheric Impact Report and the Regulations Regarding Air Dispersion Modelling (Gazette No 37804 published 11 July 2014)

The Regulations prescribing the format of the Atmospheric Impact Report (AIR) (Government Gazette No 36094; published 11 October 2013) were referenced for the air dispersion modelling approach used in this study. Table B-1 compares the AIR Regulations with the approach used in Section 5.

The draft regulations regarding Air Dispersion Modelling (Gazette No 35981 published 14 December 2012) were referenced for the air dispersion modelling approach used in this study. The promulgated Regulations Regarding Air Dispersion Modelling (Gazette No. 37804, vol 589; 11 July 2014) were consulted to ensure that the dispersion modelling process used in this assessment was in agreement with the updated regulations. Table B-2 compares the Regulations Regarding Air Dispersion Modelling with the approach used in Section 5.

Table B-1: Comparison of Regulations for the AIR with study approach

Chapter	Name	AIR regulations requirement	Status in AIR (April 2014)	Status in AIR (updated in response to stakeholder comment)
1	Enterprise details	• Enterprise Details • Location and Extent of the Plant • Atmospheric Emission Licence and other Authorisations	Enterprise details included. Location of plant included. APPA permit numbers included.	(unchanged)
2	Nature of process	• Listed Activities • Process Description • Unit Processes	All detail included in the regulated format	Updated to include all sources at the Ekandustria operations (Section 2).
3	Technical Information	• Raw Materials Used and Production Rates • Appliances and Abatement Equipment Control Technology	All raw material information included. Information on abatement equipment is confined to the listed activities seeking postponement.	Updated to include all appliance and abatement equipment (Section 3.1).

4	Atmospheric Emissions	• Point Source Emissions
		  • Point Source Parameters
		  • Point Source Maximum Emission Rates during Normal Operating Conditions
		  • Point Source Maximum Emission Rates during Start-up, Maintenance and/or Shut-down
		• Fugitive Emissions
		• Emergency Incidents
			There is no information available regarding the maximum rates available, because these are not measured, and are impractical to measure; therefore only emissions rates during normal operating conditions are available. Information regarding fugitive sources has not been included, as the modelling only considers the sources for which Sasol are requesting postponements. Information regarding emergency incidents was not included as the applications deal with normal operating conditions.	• Point Source Parameters and Emissions for MES compliant point sources have been included (Sections 4.1 and 4.2).
				• Emissions released during start-up, maintenance and/or Shut-down have been discussed (Section 4.3).
				• Management of fugitive emissions across the Ekandustria complex has been described (Section 4.4).
				• The history of Emergency Incidents during the period of assessment and planned management of future Emergency Incidents has been described (Section 4.5).

5	Impact of enterprise on receiving environment			

Chapter	Name	AIR regulations requirement	Status in AIR (April 2014)	Status in AIR (updated in response to stakeholder comment)
5.1	Analysis of emissions impact on human health	Must conduct dispersion modelling, must be done in accordance with Regulations; must use NAAQS	Completed as set out by the Regulations.	• Section 5.1.1 updated to include revision of AIR in response to stakeholder comments • Section 5.1.3 updated to reflect the promulgated Regulations Regarding Air Dispersion Modelling (also applicable throughout document) • The description of the process to identify sensitive receptors (Section 5.1.8) has been updated for clarity. • Section 5.1.8 receptor map to include schools and clinics/
5.2	Analysis of emissions impact on environment	Must be undertaken at discretion of Air Quality Officer.	Literature review included in AIR, further information also provided in the motivation reports	(unchanged)
6	Complaints	Details on complaints received for last two years	Included	(unchanged)
7	Current or planned air quality management interventions	Interventions currently being implemented and scheduled and approved for next 5 years.	Information on air quality interventions are included in detail in the motivation reports	(unchanged)
8	Compliance and enforcement history	Must set out all air quality compliance and enforcement actions undertaken against the enterprise in the last 5 years. Includes directives, compliance notices, interdicts, prosecution, fines	Included	(unchanged)
9	Additional information		Included polar plots as an additional visualisation means of ambient air quality as monitored. Independent peer review of dispersion modelling methodology by international expert consultant.	Updated with list and explanation of information included in, or annexed to, the AIR beyond the requirements, in order to support the decision-making process.

Table B-2: Comparison of draft regulations for Air Dispersion Modelling with study approach

AIR Regulations	Compliance with regulation	Comment
Levels of assessment • Level 1: where worst-case air quality impacts are assessed using simpler screening models • Level 2: for assessment of air quality impacts as part of license application or amendment processes, where impacts are the greatest within a few kilometers downwind (less than 50km) • Level 3: requires more sophisticated dispersion models (and corresponding input data, resources and model operator expertise) in situations: – where a detailed understanding of air quality impacts,	Level 2 assessment using AERMOD	AERMOD selected for the following reasons: • small domain required • flat terrain • single source of non-criteria pollutant requiring no chemical transformations

AIR Regulations	Compliance with regulation	Comment
in time and space, is required; – where it is important to account for causality effects, calms, non-linear plume trajectories, spatial variations in turbulent mixing, multiple source types, and chemical transformations; – when conducting permitting and/or environmental assessment process for large industrial developments that have considerable social, economic and environmental consequences; – when evaluating air quality management approaches involving multi-source, multi-sector contributions from permitted and non-permitted sources in an airshed; or, – when assessing contaminants resulting from non-linear processes (e.g. deposition, ground-level ozone (O_3), particulate formation, visibility)		
Model Input Source characterisation	Yes	Only Point sources characterised as per the Draft Regulations in Table 5-2.
Emission rates: For new or modified existing sources the maximum allowed amount, volume, emission rates and concentration of pollutants that may be discharged to the atmosphere should be used	Yes	Baseline emission rates used in this investigation were based on an hourly average mass flow and concentration. The maximum allowable emission rates were used in the Compliance Scenario for Existing plant standards. Emission rates used for each scenario are provided in Table 5-2.
Meteorological data Full meteorological conditions are recommended for regulatory applications.	Yes	MM5 modelled meteorology (including upper air) (Sections 5.1.1.2.1 and 5.1.5).
Data period	Yes	3 years (2010 to 2012)
Geographical Information Topography and land-use		Topography not included based on flat terrain recommendation for AERMOD. Land-use included in meteorological pre-processor (AERMET)
Domain and co-ordinate system	Yes	• Dispersion modelling domain: 5 x 5 km from center point of site. • Flat terrain • UTM co-ordinate system (WGS84)
General Modelling Considerations Ambient Background Concentrations, including estimating background concentrations in multi-source areas	No	No ambient measurements of MMA to include.

AIR Regulations	Compliance with regulation	Comment
NAAQS analyses for new or modified sources: impact of source modification in terms of ground-level concentrations should be assessed within the context of the background concentrations	No	Model-predicted 2nd highest ground-level concentrations were compared against health effect screening levels, as there are no ambient MMA concentrations available for comparison.
Land-use classification	Yes	Section 5.1.1.1
Surface roughness	Yes	Computed from land-use categories in the AERMET pre-processing step.
Albedo	Yes	Computed from Land-use categories in the AERMET pre-processing step.
Temporal and spatial resolution		
Receptors and spatial resolutions	Yes	Section 5.1.1.2.3
Building downwash	No	Insufficient data was available for building downwash quantification.
Chemical transformations	No	Not required
General Reporting Requirements		
Model accuracy and uncertainty	No	There are no ambient MMA concentrations available for comparison.
Plan of study	Yes	Section 5.1.1.1
Air Dispersion Modelling Study Reporting Requirements	Yes	As per the Regulations Prescribing the Format of the Atmospheric Impact Report, Government Gazette No. 36904, Notice Number 747 of 2013 (11 October 2013) and as per the Draft Regulations Regarding Air Dispersion Modelling (Government Gazette No. 35981 Notice 1035 or 2012, 14 December 2012).
Plotted dispersion contours	Yes	Section 5.1.3