Air Quality Scoping Report

Prepared for the Southern Waste Water Treatment Works

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Royal HaskoningDHV
Enhancing Society Together

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Glossary

Ambient air	The air of the surrounding environment.
Baseline	The current and existing condition before any development or action.
Boundary layer	In terms of the earth's planetary boundary layer is the air layer near the ground affected by diurnal heat, moisture or momentum to or from the surface.
Concentration	When a pollutant is measured in ambient air it is referred to as the concentration of that pollutant in air. Pollutant concentrations are measured in ambient air for various reasons, i.e. to determine whether concentrations are exceeding available health risk thresholds (air quality standards); to determine how different sources of pollution contribute to ambient air concentrations in an area; to validate dispersion modelling conducted for an area; to determine how pollutant concentrations fluctuate over time in an area; and to determine the areas with the highest pollution concentrations.
Condensation	The change in the physical state of matter from a gaseous into liquid phase.
Dispersion potential	The potential a pollutant has of being transported from the source of emission by wind or upward diffusion. Dispersion potential is determined by wind velocity, wind direction, height of the mixing layer, atmospheric stability, presence of inversion layers and various other meteorological conditions.
Emission	The rate at which a pollutant is emitted from a source of pollution.
Emission Factor	A representative value, relating the quantity of a pollutant to a specific activity resulting in the release of the pollutant to atmosphere.
Evaporation	The opposite of condensation
Inversion	An increase of atmospheric temperature with an increase in height.
Mixing layer	The layer of air within which pollutants are mixed by turbulence. Mixing depth is the height of this layer from the earth's surface
Oxides of Nitrogen	Refers to NO and NO_2. The gas is produced during combustion especially at high temperatures.
Particulate matter (PM)	The collective name for fine solid or liquid particles added to the atmosphere by processes at the earth's surface and includes dust, smoke, soot, pollen and soil particles. Particulate matter is classified as a criteria pollutant, thus national air quality standards have been developed in order to protect the public from exposure to the inhalable fractions. PM can be principally characterised as discrete particles spanning several orders of magnitude in size, with inhalable particles falling into the following general size fractions: * PM10 (generally defined as all particles equal to and less than 10 microns in aerodynamic diameter; particles larger than this are not generally deposited in the lung); * PM2.5, also known as fine fraction particles (generally defined as those particles with an aerodynamic diameter of 2.5 microns or less) ; * PM10-2.5, also known as coarse fraction particles (generally defined as those particles with an aerodynamic diameter greater than 2.5 microns, but equal to or less than a nominal 10 microns); and * Ultra fine particles generally defined as those less than 0.1 microns.

Precipitation	Ice particles or water droplets large enough to fall at least 100 m below the cloud base before evaporating.
Relative Humidity	The vapour content of the air as a percentage of the vapour content needed to saturate air at the same temperature
Wastewater treatment plant	An industrial structure designed to remove biological or chemical waste products from water, thereby permitting treated water to be used for other purposes.

1 INTRODUCTION

Royal HaskoningDHV was appointed by AECOM to conduct an Air Quality Impact Assessment for the proposed upgrades at the Southern Waste Water Treatment Works (SWWTW) and Solids Removal Facility located in the Durban South Basin, Kwa-Zulu Natal (Figure 1-1). The SWWTW is located in Merewent on the eastern bank of the Umlass Canal. The WWTW is surrounded by residential and industrial development. The aim of the proposed upgrades is to reduce the quantity of industrial raw sludge being disposed of through the sea outfall by developing new sludge treatment infrastructure.

This study aims to assist in the development of a scoping study for the site and to determine the potential air quality impacts associated during the proposed upgrades. As part of the scoping report, a baseline assessment was undertaken which includes a review of available meteorological data to evaluate the prevailing meteorological conditions in the area. The baseline air quality situation was assessed through a review of meteorological data which was obtained from the South African Weather services for the period of Jan 2009 - Dec 2013. During the impact assessment phase, the potential odour impacts from the proposed project on the surrounding environment will be evaluated through the compilation of an emissions inventory and subsequent dispersion modelling simulations using the AERMOD dispersion model. Passive monitoring will also take place during the impact assessment phase in order to compare the modelled results to monitored data.

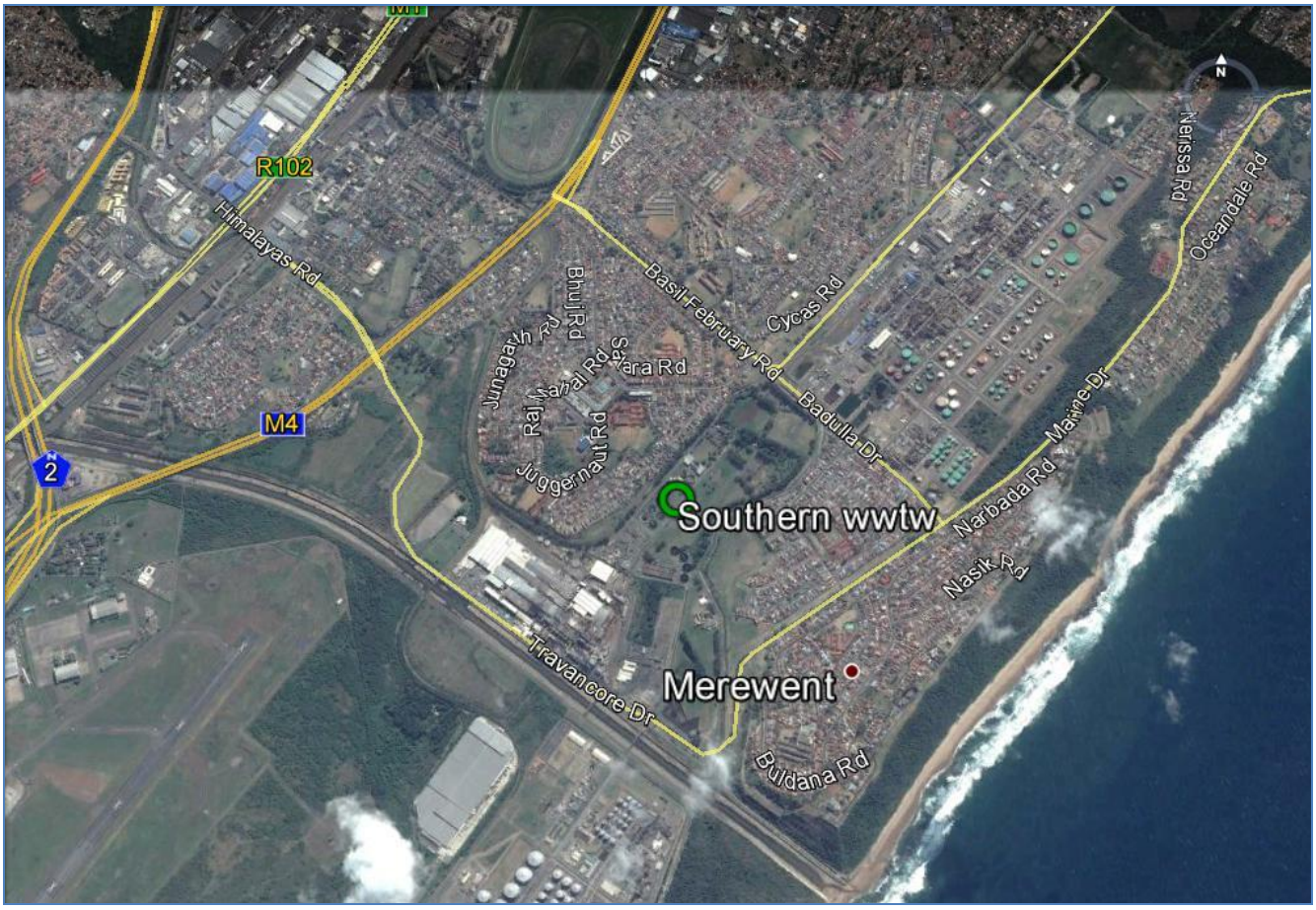

Figure 1-1: Location of the Site

1.1 Process Description

The Southern waste water treatment works disposes of a large portion of its effluent and sludge to the Indian Ocean through a 4.2 Km outfall. The balance is treated in a conventional activated sludge plant. The works currently treats an average flow of 130 Ml/day from the Southern areas of Durban, Chatsworth and Umlazi. The flow consists of domestic sewage and industrial effluent from the Mobeni and Jacobs's area. Waste water discharged from road tanker and sewers owned by industry also enter the works, but bypasses all treatment processes and is discharged directly to the sea outfall.

Waste water received at the head of works undergoes screening and degritting before being passed through primary settling tanks. Sludge from the primary settling tanks is removed and degritted in hydro clones before being added back to the primary effluent for discharge through the ocean outfall. Scum is removed from the primary settling tanks and disposed of at the Bisasar Road landfill site together with collected grit and screening.

A gravity thickener and anaerobic digesters are available but are no longer used as the discharge license from the department of water affairs allows raw sludge to be discharged to sea. The average discharge into the ocean outfall is 130 ML/day. However the outfall has a design capacity of approximately 215 Ml/day under pump discharge. The conventional activated sludge plant has a capacity of 48Ml/day. The feed to the plant is domestic sewage removed from the Chatsworth Line.

1.2 Terms of Reference

The terms of reference for the Air Quality Impact Assessment for the proposed project can be summarised as follows:

- **Baseline Assessment**
    - Provide an overview of the prevailing meteorological conditions in the area;
    - Review applicable legislation and policies related to air quality management which are applicable to the treatment works;
    - Review potential health effects associated with emissions released from the proposed upgrades;
    - Identification of existing sources of emission and surrounding sensitive receptors, such as local communities, surrounding the treatment works;
    - Assess the baseline air quality using available ambient air quality monitored data;

- **Impact Assessment**
    - Compilation of an emissions inventory for the proposed air quality related sources identified on site;
    - Dispersion modelling simulations undertaken using AERMOD to determine the potential air quality impacts of the proposed activities on the surrounding area;
    - Comparison of the modelled results to the National ambient air quality standards to determine compliance;
    - Provide recommendations for the implementation of appropriate mitigation measures
    - Compilation of an Air Quality Impact Assessment Report.

1.3 Methodology

An overview of the methodological approach to be followed during this Air Quality Baseline and Atmospheric Impact Assessment is outlined in the section which follows.

1.3.1 Baseline Assessment

During the baseline assessment, a qualitative approach was used to assess the baseline conditions in the project area. Meteorological data was obtained from the South Weather Services Monitoring station located in the Durban South Basin for the January 2009 to December 2013 monitoring period. Applicable air quality legislation was reviewed and criteria pollutants relevant to the project and their potential human health effects are also discussed.

Existing sources of air pollution surrounding the plant were qualitatively assessed. Sensitive receptors, such as local communities in close proximity to the treatment works will be identified primarily through site visit and satellite imagery.

1.3.2 Impact Assessment

During this phase, an emissions inventory will be compiled to estimate emissions from the identified emission sources associated with the proposed upgrades and activities on site. Dispersion modelling simulations were undertaken using the AERMOD dispersion model and presented graphically as Isopleths plots. Comparison with the National ambient air quality standards (GN263; 2009) will be made to determine compliance. Based on the predicted results, recommendations for appropriate mitigation measures would be provided.

1.3.2.1 *Overview of the ISC/ Aermod Dispersion Model*

Dispersion modelling will be undertaken using the US EPA approved Aermod Model. Aermod is based on the Gaussian plume equation and is capable of providing ground level concentration estimates of various averaging times, for a number of meteorological and emission source configuration (Point, area, volume sources for gaseous and particle emissions). Input data into Aermod includes: source and receptor data, meteorological parameters and terrain data. The meteorological data includes: wind velocity and direction, ambient temperature, mixing heights, stability class, barometric pressure, average precipitation and relative humidity.

1.3.2.2 *Overview of the WATER9 (Waste water treatment) Model*

WATER9 is a Windows based program and consists of analytical expressions for estimating air emissions of individual waste constituents in waste water collection, storage, and treatment and disposal facilities; a data base listing many of the organic compounds and procedures for obtaining reports of constituent fates, including air emissions and treatment effectiveness. WATER9 is used to estimate air emissions from site specific water treatment plants (including the prediction of biodegradation and sludge sorption or organics) for common waste water treatment units.

Once the WATER9 emission estimates have been made and the Aermod model has been run, an output of impacts will be provided. The assessment of ambient air quality impacts will then be undertaken by comparing Aermod results, with local and international guidelines and standards for the pollutants identified.

1.4 Report Structure

Section 1 of the report provides the background to the project. **Section 2** includes a meteorological overview of the region. A review of applicable air quality legislation, pollutants and their potential health effects, baseline air quality situation are presented in **Section 3**. **Section 4** gives a summary of the general impacts associated with the proposed upgrade at the SWWTW. **Section 5** gives a list of the references.

2 BASELINE DESCRIPTION OF THE AREA

2.1 Meso-Scale Meteorology

The nature of the local climate will determine what will happen to particulates when released into the atmosphere (Tyson & Preston-Whyte, 2000). Concentration levels fluctuate daily and hourly, in response to changes in atmospheric stability and variations in mixing depth. Similarly, atmospheric circulation patterns will have an effect on the rate of transport and dispersion.

The release of atmospheric pollutants into a large volume of air results in the dilution of those pollutants. This is best achieved during conditions of free convection and when the mixing layer is deep (unstable atmospheric conditions). These conditions occur most frequently in summer during the daytime. This dilution effect can however be inhibited under stable atmospheric conditions in the boundary layer (shallow mixing layer). Most surface pollution is thus trapped under a surface inversion (Tyson & Preston-Whyte, 2000).

Inversion occurs under conditions of stability when a layer of warm air lies directly above a layer of cool air. This layer prevents a pollutant from diffusing freely upward, resulting in an increased pollutant concentration at or close to the earth's surface. Surface inversions develop under conditions of clear, calm and dry conditions and often occur at night and during winter (Tyson & Preston-Whyte, 2000). Radiative loss during the night results in the development of a cold layer of air close to the earth's surface. These surface inversions are however, usually destroyed as soon as the sun rises and warm the earth's surface. With the absence of surface inversions, the pollutants are able to diffuse freely upward; this upward motion may however be prevented by the presence of an elevated inversion (Tyson & Preston-Whyte, 2000).

Elevated inversions occur commonly in high pressure areas. Sinking air warms adiabatically to temperatures in excess of those in the mixed boundary layer. The interface between the upper, gently subsiding air is marked by an absolutely stable layer or an elevated subsidence inversion. This type of elevated inversions is most common over Southern Africa (Tyson & Preston-Whyte, 2000).

The climate and atmospheric dispersion potential of the interior of South Africa is determined by atmospheric conditions associated with the continental high pressure cell located over the interior. The continental high pressure present over the region in the winter months results in fine conditions with little rainfall and light winds with a northerly flow. Elevated inversions are common in such high pressure areas due to the subsidence of air. This reduces the mixing depth and suppresses the vertical dispersion of pollutants, causing increased pollutant concentrations (Tyson and Preston-Whyte, 2000).

Seasonal variations in the positions of the high pressure cells have an effect on atmospheric conditions over the region. For most of the year the tropical easterlies cause an air flow with a north-easterly to north-westerly component. In the winter months the high pressure cells move northward, displacing the tropical easterlies northward resulting in disruptions to the westerly circulation. The disruptions result in a succession of cold fronts over the area in winter with pronounced variations in wind direction, wind speeds, temperature, humidity, and surface pressure. Airflow ahead of a cold front passing over the area has a strong north-north-westerly to north-easterly component, with stable and generally cloud-free conditions. Once the front has passed, the airflow is reflected as having a dominant southerly component (Tyson and Preston-Whyte, 2000).

Easterly and westerly wave disturbances cause a southerly wind flow and tend to hinder the persistence of inversions by destroying them or increasing their altitude, thereby facilitating the dilution and dispersion of pollutants. Pre-frontal conditions tend to reduce the mixing depth. The potential for the accumulation of pollutants during pre-frontal conditions is therefore enhanced over the plateau (Tyson and Preston-Whyte, 2000).

2.1.1 Wind

Wind roses comprise of 16 spokes which represents the direction from which the winds blew during the period under review. The colours reflect the different categories of wind speeds. The dotted circles provide information regarding the frequency of occurrence of wind speed and direction categories.

Based on an evaluation of the site specific meteorological data obtained from the South African Weather Services in the Durban South Area, Kwa-Zulu Natal, the following deductions regarding the prevailing wind direction and wind frequency can be presented. Based on Figure 2-1 below, the predominant wind direction for the area under review occurs mainly from the north eastern and south western regions. Secondary winds were noted from the north western and south eastern quadrants.

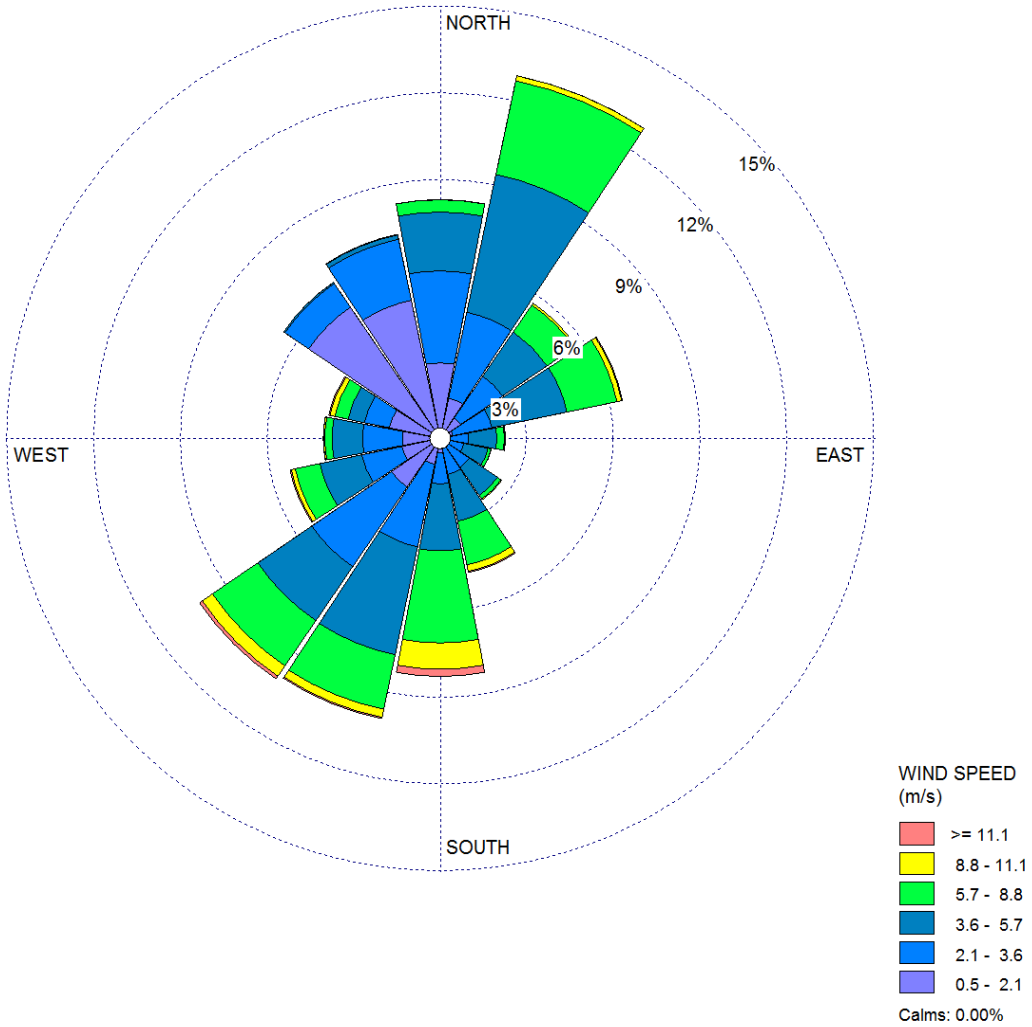

Figure 2-1: Periodic Wind Rose for the Jan 2009 – Dec 2013 Monitoring Period

Figure 2-3 below illustrates the wind class frequency distribution for the 2009 -2013 monitoring period. No calm winds were experienced during the monitoring period. 27.8% of the total wind speeds experienced fell within the 3.6 -5.7 m/s wind class, while 26.7 % of the total wind speeds fell within the 2.1 – 3.6 m/s wind class.

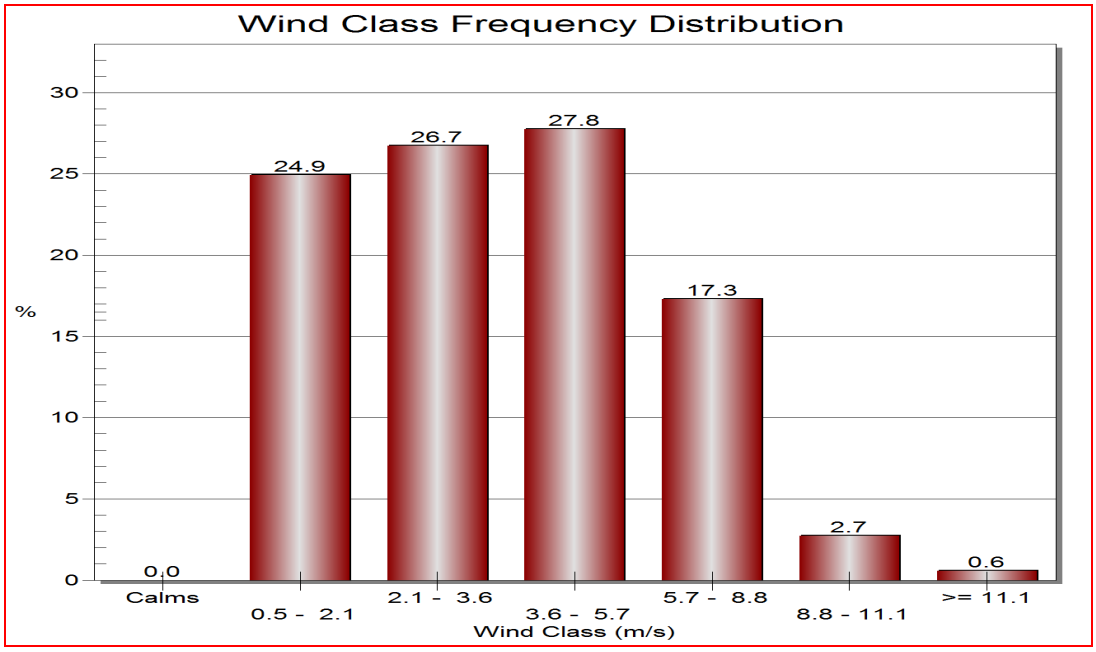

Figure 2-2: Wind class frequency distribution

2.1.2 Atmospheric stability

Atmospheric stability is commonly categorised into one of seven stability classes. These are briefly described in Table 2-1 below. The atmospheric boundary layer is usually unstable during the day due to turbulence caused by the sun's heating effect on the earth's surface. The depth of this mixing layer depends mainly on the amount of solar radiation, increasing in size gradually from sunrise to reach a maximum at about 5-6 hours after sunrise. The degree of thermal turbulence is increased on clear warm days with light winds. During the night a stable layer, with limited vertical mixing, exists. During windy and/or cloudy conditions, the atmosphere is normally neutral. A neutral atmospheric potential neither enhances nor inhibits mechanical turbulences. An unstable atmospheric condition enhances turbulence, whereas a Stable atmospheric condition inhibits mechanical turbulence.

Table 2-1: Atmospheric Stability Class

A	Very unstable	calm wind, clear skies, hot daytime conditions
B	Moderately unstable	clear skies, daytime conditions
C	Slightly Unstable	moderate wind, slightly overcast daytime conditions
D	Neutral	high winds or cloudy days and nights
E	Slightly Stable	moderate wind, slightly overcast night-time conditions
F	Moderately stable	low winds, clear skies, cold night-time conditions
G	Very stable	Calm winds, clear skies, cold clear night-time conditions

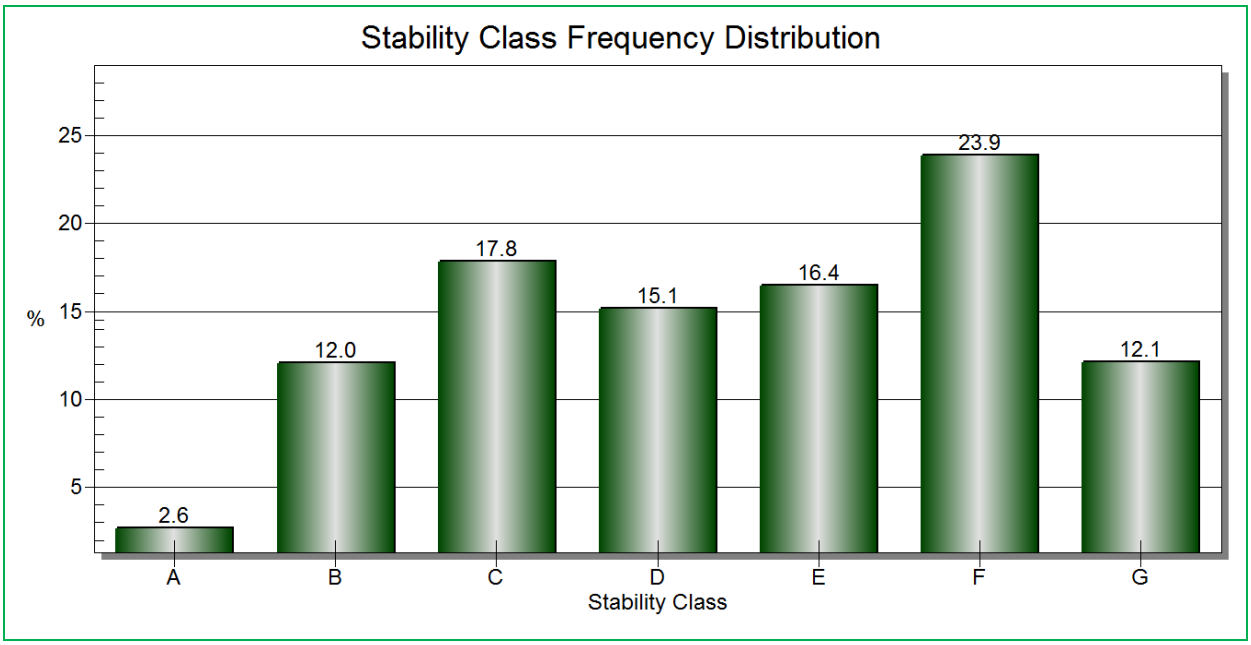

Figure 2-3: Wind Class Frequency Distribution

2.1.3 Temperature and Humidity

Temperature affects the formation, action, and interactions of pollutants in various ways (Kupchella & Hyland, 1993). Chemical reaction rates tend to increase with temperature and the warmer the air, the more water it can hold and hence the higher the humidity. Temperature also provides an indication of the rate of development and dissipation of the mixing layer as well as determining the effect of plume buoyancy; the larger the temperature difference between the plume and ambient air, the higher the plume is able to rise.

Higher plume buoyancy will result in an increased lag time between the pollutant leaving the source, and reaching the ground. This additional time will allow for greater dilution and ultimately a decrease in the pollutant concentrations when reaching ground level.

Humidity is the mass of water vapour per unit volume of natural air. When temperatures are at their highest the humidity is also high, the moisture is trapped inside the droplets of the water vapour. This makes the moisture content of the air high. When relative humidity exceeds 70%, light scattering by suspended particles begins to increase, as a function of increased water uptake by the particles (CEPA/FPAC Working Group, 1999). This results in decreased visibility due to the resultant haze. Many pollutants may also dissolve in water to form acids, as well as secondary pollutants within the atmosphere.

The average monthly temperature and relative humidity for the Jan 2008 - Dec 2013 monitoring period is presented in Figure 2-4 below. Daily average summer temperatures ranged between 22.5 ºC – 25.1 ºC, while the average winter temperatures ranged between 16.8 ºC – 20.0 ºC. Relative Humidity for the Jan 2009 – Dec 2013 monitoring period was highest during the summer months of Dec, Jan and Feb and lowest during the winter months.

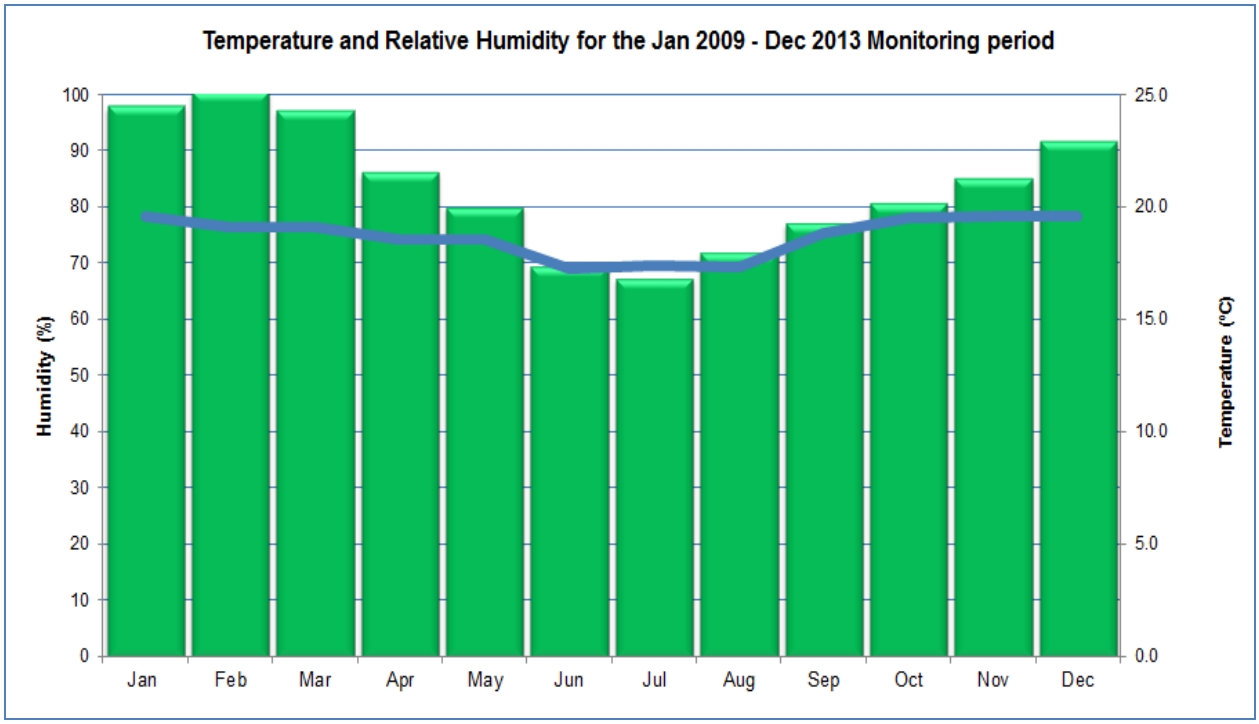

Figure 2-4: Average Temperature and Relative Humidity for the Jan 2009 – Dec 2013 Monitoring Period.

2.1.4 Precipitation

Precipitation cleanses the air by washing out particles suspended in the atmosphere (Kupchella & Hyland, 1993). It is calculated that precipitation accounts for about 80-90% of the mass of particles removed from the atmosphere (CEPA/FPAC Working Group, 1999).

Summary of the total rainfall profile for the January 2009 – December 2013 monitoring period is illustrated in **Error! Reference source not found.** Figure 2-5 below. The spring and summer months recorded the highest rainfall with 242.26 mm and 250.76mm respectively. The winter months recorded the lowest average of precipitation with 92.24mm.

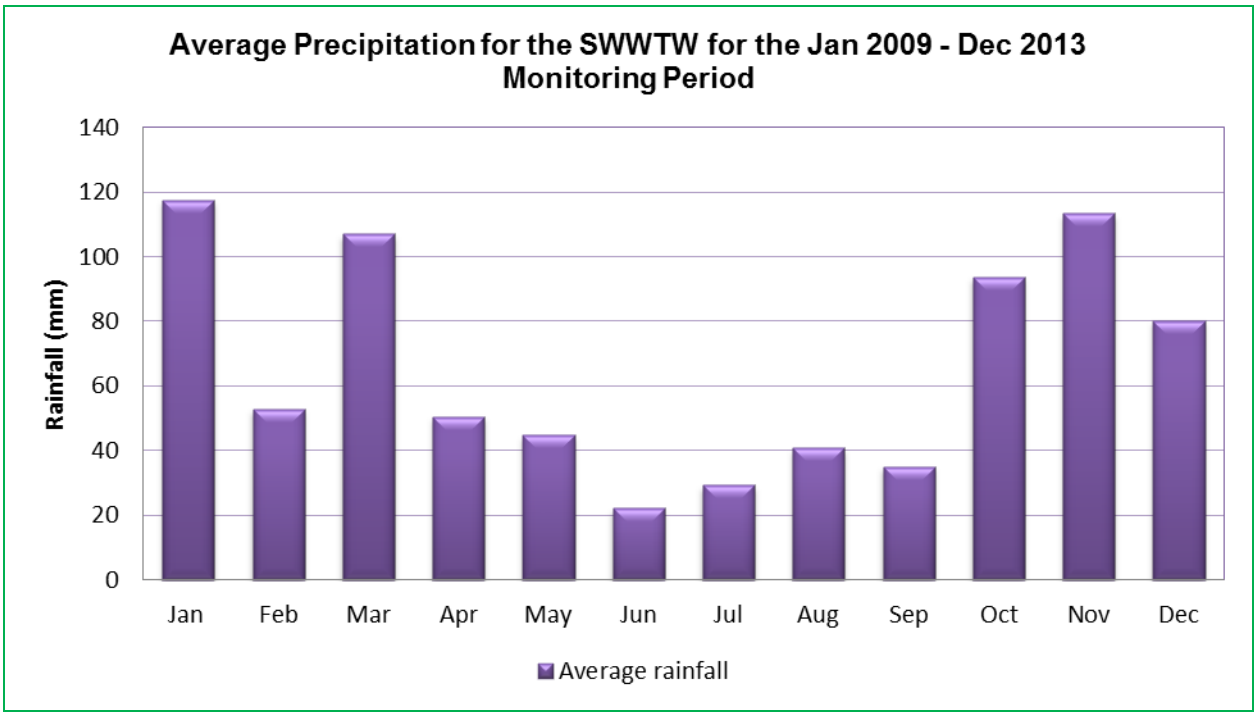

Figure 2-5: Average Precipitation for the Jan 2009 – Dec 2013 Monitoring period for the Southern Waste Water Treatment Works.

3 APPLICABLE LEGISLATION

3.1 South African legislative and standards frameworks

3.1.1 National Environmental Management: Air Quality Act 39 of 2004

The National Environmental Management: Air Quality Act 39 of 2004 has shifted the approach of air quality management from source-based control to receptor-based control. The main objectives of the Act are to:

- Give effect to everyone's right 'to an environment that is not harmful to their health and well-being'
- Protect the environment by providing reasonable legislative and other measures that (i) prevent pollution and ecological degradation, (ii) promote conservation and (iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development

The Act makes provision for the setting and formulation of national ambient air quality standards for 'substances or mixtures of substances which present a threat to health, well-being or the environment'. More stringent standards can be established at the provincial and local levels.

The control and management of emissions in AQA relates to the listing of activities that are sources of emission and the issuing of emission licences. Listed activities are defined as activities which 'result in atmospheric emissions and are regarded to have a significant detrimental effect on the environment, including human health'. Listed activities have been identified by the minister of the Department of Environmental Affairs and atmospheric emission standards have been established for each of these activities. These listed activities now require an atmospheric emission licence to operate. The issuing of emission licences for Listed Activities is the responsibility of the metropolitan and district municipalities.

In addition, the minister may declare any substance contributing to air pollution as a priority pollutant. Any industries or industrial sectors that emit these priority pollutants will be required to implement a Pollution Prevention Plan. Municipalities are required to 'designate an air quality officer to be responsible for co-ordinating matters pertaining to air quality management in the Municipality'. The appointed Air Quality Officer is responsible for the issuing of atmospheric emission licences.

3.1.2 National Ambient Air Quality Standards

Air quality guidelines and standards are fundamental to effective air quality management, providing the link between the source of atmospheric emissions and the user of that air at the downstream receptor site. The ambient air quality guideline values indicate safe daily exposure levels for the majority of the population, including the very young and the elderly, throughout an individual's lifetime. Air quality guidelines and standards are normally given for specific averaging periods. These averaging periods refer to the time-span over which the air concentration of the pollutant was monitored at a location. Generally, five averaging periods are applicable, namely an instantaneous peak, 1-hour average, 24-hour average, 1-month average, and annual average.

The Department of Environmental Affairs and Tourism (DEAT) have issued ambient air quality guidelines to support receiving environment management practices. Ambient air quality guidelines are only available for such criteria pollutants which are commonly emitted, such as Particulates, SO_2, Pb, NO_x, benzene and CO. The guidelines specific to the relevant pollutants during this assessment are detailed in the sections below.

3.1.2.1 *Volatile organic compounds*

Volatile Organic Compounds (VOCs) are compounds that have a high vapour pressure at ordinary, room-temperature conditions. It is noted that some organic compounds have little or no known direct human health effects, while others are extremely toxic and/or carcinogenic. The USEPA has classified benzene as a Group A, known human carcinogen. Increased incidence of leukemia (cancer of the tissues that form white blood cells) has been observed in humans occupationally exposed to benzene. The USEPA has derived a range of inhalation cancer unit risk estimates for benzene. The value at the high end of the range was used in this assessment. Chronic (long-term) inhalation exposure has caused various disorders in the blood, including reduced numbers of red blood cells and aplastic anemia, in occupationally exposed humans. Reproductive effects have been reported in women exposed by inhalation to high levels of benzene, and adverse effects on the developing fetus have been observed in animal tests (USEPA, 2001).

The USEPA calculated a range of $2.2x10^{-5}$ to $7.8x10^{-6}$ as the increase in the lifetime cancer risk to an individual who is continuously exposed to 1 µg/m^3 of benzene in the air over his or her lifetime. EPA estimates that, if an individual were to continuously breathe air containing benzene at an average of 0.13 to 0.45 µg/m^3 over his or her entire lifetime, that person would have no more than a 1 in a million increased chance of developing cancer as a direct result (USEPA, 2001).

Chronic inhalation of certain levels of benzene causes disorders in the blood of humans. Benzene specifically affects bone marrow (the tissues that produce blood cells). Aplastic anemia, excessive bleeding, and damage to the immune system (by changes in blood levels of antibodies and loss of white blood cells) may develop. In animals, chronic inhalation and oral exposure to benzene produce the same effects as seen in humans. Reproductive effects have been reported for women exposed by inhalation to high levels, and adverse effects on the developing fetus have been observed in animal tests (USEPA, 2001).

Benzene is the only VOC for which a National ambient air quality standard has been established. An annual average standard of 10 µg/m^3 and 5 µg/m^3, respectively, has been established for current and future compliance (1 Jan 2015). Although standards for exposure to VOCs in non-industrial settings do not exist, a number of exposure limits have been recommended. The European Collaborative Action (ECA) Report No. 11 titled *Guidelines for Ventilation Requirements in Buildings* (CEC, 1992) lists the following total volatile organic compound (TVOC) concentration ranges as measured with a flame ionisation detector calibrated to toluene. These recommendations are based on Mølhave's toxicological work on mucous membrane irritation (Mølhave, 1990).

Comfort range:	<200 µg/m³
Multi-factoral exposure range:	200 to 3 000 µg/m³
Discomfort range:	3 000 to 25 000 µg/m³
Toxic range:	>25 000 µg/m³

The same European report also lists a second method based on Seifert's work (Seifert, 1990). This method established TVOC guidelines based on the ten most prevalent compounds in each of seven chemical classes. The concentrations in each of these classes should be below the maximums listed below.

Alkanes:	100 µg/m³
Aromatic hydrocarbons:	50 µg/m³
Terpenes:	30 µg/m³
Halocarbons:	30 µg/m³
Esters:	20 µg/m³
Aldehydes and ketones (excl. formaldehyde):	20 µg/m³
Other:	50 µg/m³

The TVOC concentration is calculated by adding the totals from each class. Seifert gives a target TVOC concentration of 300 µg/m³ which is the sum of the above listed target concentrations. The author also states that no individual compound concentration should exceed 50 percent of the guideline for its class or 10 percent of the TVOC guideline concentration. However, Seifert states that "…the proposed target value is not based on toxicological considerations but – to the author's best judgement."

3.1.2.2 *Health and Nuisance Evaluation Criteria*

The following section summarises the ambient guidelines for the pollutants applicable in this study. South African Air Quality standards will be used as a basis for comparison; however reference will be made to international guidelines to ensure complete compliance

Table 3-1: Ambient Air Quality Guidelines applicable to the study

Pollutant	Averaging period	US –EPA (µg/m^3) (µg/m^3)	California (µg/m^3)
Ammonia	Hourly average		
	Annual average	100	
Hydrogen Sulphide	30 minute average	7	
	Hourly average		10
	Daily average	150	
	Annual average		42
Acetone	Hourly average		
	Annual average		
Benzene	Hourly average	30	60
	Annual average		1300
Chloroform	Hourly average		300
	Annual average		150
Methanol	Hourly average		28000
	Annual average		4000
Phenol	Hourly average		5800
	Annual average		200
Toulene	Hourly average		37000
	Annual average	5000	300

3.1.2.3 *Cancer Risk Assessment*

Unit risk factors are applied in the calculation of carcinogenic risks. These factors are defined as the estimated probability of a person (60-70 kg) contracting cancer as a result of constant exposure to an ambient concentration of 1 µg/m³ over a 70-year lifetime. In the generic health risk assessment undertaken as part of the current study, maximum possible exposures (24-hours a day over a 70-year lifetime) are assumed for all areas beyond the boundary of the proposed development site. Unit risk factors were obtained from the WHO (2000) and from the US-EPA IRIS database (accessed May 2005). Unit Risk Factors for compounds of interest in the current study are given in Table 2-8.

The definition of what is deemed to be an acceptable risk remains one of the most controversial aspects of risk characterization studies. An important point to be borne in mind is the crucial distinction between voluntary and involuntary risks. The risk to which a member of the public is exposed from an industrial activity is an involuntary one. In general, people are prepared to tolerate higher levels of risk for hazards to which they exposure themselves voluntarily. There appears to be a measure of uncertainty as to what level of risk would be acceptable to the public. Pollutants are often excluded from further assessment when they contribute an individual risk of less than 1×10^{-7}. (A carcinogenic risk of 1×10^{-7} corresponds to a one-in ten- million chance of an individual developing cancer during their lifetime.) The US-EPA adopts a 1 in a million chance for cancer risks (i.e. 1×10^{-6}), applied to a person being in contact with the chemical for 70 years, 24-hours per day. Although a risk of 10^{-7} (1 in 10 million) would be desirable, and a risk of less than 10^{-6} (1 in 1 million) acceptable in terms of US regulations, some authors (Kletz, 1976; Lees, 1980; Travis *et al*., 1987) suggest that a risk level of between 10^{-5} and 10^{-6} per year (i.e. 1:100 000 and 1: 1000 000) could still be acceptable. Further work by Travis *et al*. (1987) indicated that for small populations, risks of less than 10^{-4} (1 in 10 000) may also potentially be acceptable, whereas risks greater than 10^{-4} are likely to prompt action. Locally the Department of Environmental Affairs and Tourism (DEAT) has only been noted to give an indication of cancer risk acceptability in the case of dioxin and furan exposures. According to the DEAT, emissions of dioxins and furans from a hazardous waste incinerator may not result in an excess cancer risk of greater than 1: 100 000 on the basis of annual average exposure (DEAT, 1994). Excess cancer risks of less than 1:100 000 appear therefore to be viewed as acceptable to the DEAT.

Table 3-2: Cancer risk factors for compounds investigated at the waste water treatment works.

Compound	US EPA Cancer Risk factor
Benzene	$2.2E^{6} – 7.8\ E^{-6}$
Chloroform	$2.3\ E^{-5}$

3.1.2.4 *Odour Impact Evaluation*

Odour thresholds are defined in several ways including absolute perception thresholds, recognition thresholds and objectionability thresholds. At the perception threshold one is barely certain that an odour is detected but it is too faint to identify further. Recognition thresholds are normally given for 50% and 100% recognition by an odour panel. The acute WHO guideline values given for odourants most frequently represent odour limits rather than health risk thresholds as was indicated in

Table 3-3: Odour Threshold values for odour compounds

Pollutant	Odour Recognition thresholds		Other odour thresholds	WHO
	100% Recognition	50% Recognition		
	µg/m^3	µg/m^3	µg/m^3	µg/m^3
Ammonia			500 (a)	
Hydrogen sulphide	1430	11.2	4.29 (a)	7
Acetone			1100 (a)	
Benzene			3000 (b)	
Chloroform			20000 (c)	
Methanol			2660 (b)	
Phenol			184	
Toluene			700	1000

a) South African guideline (personnel communication, M Lloyd, 8/10/98).

b) Odour threshold concentration (Verschueren, 1996).

c) Absolute perception threshold (Verschueren, 1996).

- **Evaluation Odour Impact Accessibility**

Due to the absence of detailed local guidance, reference was made to the international literature in identifying a suitable method to use in assessing the potential acceptability of odour impacts associated with the proposed landfill. Reference was primarily made to approaches adopted in the US and in Australia due to the availability of literature on the approaches adopted in these countries.

There are two main steps in odour assessment, viz.: (i) calculation of odour units based on predicted or measured ground level air pollution concentrations, and (ii) evaluation of odour unit acceptability based on defined odour performance criteria. The manners in which these steps are carried out are discussed in subsequent subsections and a method recommended for adoption in the current study.

- **Odour unit calculation**

The detectability of an odour is a sensory property that refers to the theoretical minimum concentration that produces an olfactory response or sensation. This point is called the odour thresholds and defines one odour unit per cubic metre (OU/m^3). I.e. The odour unit is the concentration of a substance divided by the odour threshold for that substance or the number of dilutions required for the sample to reach the threshold. This threshold is typically the numerical value equivalent to when 50% of a testing panel correctly detect an odour. Therefore, an odour criterion of less than 1 OU/m^3 would theoretically result in no odour impact being experienced.

Different states in the US and Australia apply varying methodologies in the calculation of odour units and also differ in their selection of suitable detection limits. Examples of such differences include the following:

- *Averaging periods* - the New South Wales (NSW) EPA (2001b) and Victoria EPA recommend the use of 3-minute average air pollution concentrations in OU calculation, whereas the Draft Queensland EPA (1999) guideline refers to 1-hour averages.
- *Percentiles* - the NSW EPA (2001b) specify the use of the 99.9th percentile when selecting 3-minute averaging air pollutant concentrations to be used in OU calculation given a "level 3"[1] assessment. The Queensland and Victoria EPAs both recommend that the 99.5th percentile be used.
- *Detection Limits (Refer to detection by human olfactory system)* - the NSW EPA includes odour detection levels in a Technical Note as the basis for the calculation of odour units. These detection levels were found to be very low in certain instances representing the lower bounds of the detection range. The California Air Resources Board (CARB) refers to a detection range and specifies the use of the geometric mean for use as a detection threshold for use in odour unit estimation. E.g. For hydrogen sulphide the NSW EPA detection limit is given as 0.14 µg/m³, whereas the CARB recognise a detection range of 0.098 µg/m³ to 1960 µg/m³ but specify the use of the geometric mean which is 11.2 µg/m³ (0.008 ppm).

- **Odour Performance Criteria**

In practice, the character of a particular odour can only be judged by the receiver's reaction to it, and preferably only compared to another odour under similar social and regional conditions. The NWS EPA, having referred to the literature in its determining the level at which an odour is perceived to be of nuisance, gives this level as ranging from 2 OU/m³ to 10 OU/m³ depending on a combination of the following factors:

- *Odour Quality* – whether the odour results from a pure compound or from a mixture of compounds (Pure compounds tend to have higher threshold, lower offensiveness than a mixed compound)
- *Population Sensitivity* - any given population contains individuals with a range of sensitivities to odour. The larger the population, generally the greater the number of sensitive individuals contained.
- *Background Level* - refers to the likelihood of cumulative odour impacts due to the co-location of sources emitting odours
- *Public expectation* - whether a given community is tolerant of a particular type of odour and does not find it offensive. Background agricultural odours may, for example, not be considered offensive until a higher threshold is reached whereas odours from a waste disposal site or chemical facility may be considered offensive at lower thresholds.
- *Source Characteristics* – emissions from a point source are more easily controlled than those that are diffused, e.g.: waste disposal sites
- *Health Effects* – whether a particular odour is likely to be associated with adverse health effects. In general, odour from an agricultural operation is less likely to present a health risk than emissions from a waste disposal or chemical facility.

Experience gained in NSW through odour assessments for proposed and existing facilities has indicated that an odour performance criterion of 7 OU/m³ is likely to represent the level below which "offensive" odours should not occur for an individual with a "standard sensitivity"[2] to odours.

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[1] A level 3 assessment requires that comprehensive atmospheric dispersion modelling be done, as opposed to screening dispersion modelling acceptable in a level 2 odour impact assessments.

[2] "Standard Sensitivity" is defined by the Draft Australia and European CEN Standards, which require that the geometric mean of individual odour thresholds estimates must fall between 20 ppb and 80 ppb for n-butanol (the reference compound).

The NSW EPA policy therefore recommends that, as a design criteria, no individual be exposed to ambient odour levels of greater than 7 OU/m^3. Where a number of the factors listed above simultaneously contribute to making an odour 'offensive', an odour criteria of 2 OU/m^3 at the nearest sensitive receptor (existing or any likely future receptor) is appropriate. This is given as generally occurring for affected populations equal to or above 2000 people. A summary of the NSW EPA's odour performance criteria for various population densities is shown in the table below.

Table 3-4: NSW EPA odour performance criteria defined based on population density (NSW EPS, 2001a).

Population of Affected Community	Odour performance criteria (odour units/m^3) [(a)]
Urban area (>2000)	2.0
500 – 2000	3.0
125 – 500	4.0
30 – 125	5.0
10 – 30	6.0
Single residences (≤2)	7.0

a) The NSW EPA indicate that these should be regarded as interim criteria to be refined over time through experience and case studies. The EPA makes provision for the future updating of the odour performance criteria as new industry-specific research is completed, with the acceptable procedure for developing future criteria being outlined in a Technical Note.

b)

The odour performance criteria specified by the NSW EPA is compared to that used in other jurisdictions in the table below. It is evident that the odour performance criteria range specified by the NSW EPA includes the criteria stipulated in various other jurisdictions. The exception being the South Coast Air Quality Management District in the US which permits odour units of up to 10 OU in certain instances.

Table 3-5: Odour performance criteria used in various jurisdiction in the US and Australia (after NSW EPA, 2001b).

Jurisdiction	Odour Performance Criteria (given for application to odour units) (OU)
New South Wales EPA (NSW EPA, 2001a, 2001b)	2 to 7
California Air Resources Board (Amoore, 1999)	5
South Coast Air Quality Management District (SCAQMD) (CEQA, 1993)	5 to 10
Massachusetts (Leonardos, 1995)	5
Connecticut (Warren Spring Laboratory, 1990)	7
Queensland (Queensland Department of Environment and Heritage, 1994)	5

- **Recommended approach for use in current study**

It is recommended that the NSW EPA draft approach (NSW EPA, 2001a and 2001b) be largely adopted for use in the current study given that it has been recently drafted and is comprehensively documented. Reference will, however, be made to the CARB method of selecting detection limits for use in the odour unit calculation. The approach recommended may be summarised as follows:

(i) 3-minute average air pollutant concentrations will be calculated based on predicted 1-hourly average concentrations (since most dispersion models, including the Australian regulatory model Ausplume and the US-EPA regulatory model used in this study, do not allow for the prediction of averages over a shorter time interval than 1 hour);

The equation for calculating concentrations for different averaging periods than the period over which they were monitored can be seen below. Although this is a function of both source configuration and atmospheric turbulence, it can be generally shown that concentrations obtained over different averaging times are related as follows:

$$C1/C2 = (T2/T1)^{p}$$

Where

C1 and C2 are concentrations for averaging times T1 and T2, respectively;
T1 and T2 are any two averaging times;
P is a parameter ranging from 0.16 to 0.68, depending on the atmospheric stability. Most widely used values range between 0.16 and 0.25. Until locally derived values become available, it is recommended to use 0.2. For the purpose of the current study a value of 0.68 was applied to provide for a conservative assessment of the potential for short term peaks in ambient concentrations.

(ii) recognition of the detection range for a substance and calculation of the geometric mean detection limit within the range;
(iii) calculation of odour units by calculating ratios between the 99.9th percentile 3-minute average air pollutant concentrations and the respective geometric mean detection limits; and
(iv) application of the odour performance criteria set out by the NSW EPA in Figure 2-7

It is recognised that the NSW EPA odour assessment procedure is still a draft procedure and that the odour performance criteria are given as being interim criteria to be tested in the field and modified as necessary (NSW EPA, 2001b). The above approach is similarly recommended as a test method, with experience gained locally in the field to be used to inform and tailor this approach.

- **Application of odour performance criteria**

It is interesting to note how odour assessment and management is carried out in countries in which the regulators have documented approaches. The procedure outlined, for example, by the NSW EPA for the assessment of odour impacts for existing facilities is depicted in Figure 3-1 below. It is notable that the NSW EPA's odour performance criteria are not used as environment protection licence conditions. Compliance with these criteria is considered difficult to measure and therefore meaningless as licence conditions.

The NSW EPA policy identifies the potential for using negotiation between stakeholder to deal with cases where feasible and reasonable avoidance and mitigation strategies would not curb all potentially offensive odour impacts. Such negotiation processes are generally only regarded to be relevant to odour management for existing facilities. It is recommended that any negotiated solution between a facility operator and a neighbour be formalised (e.g. though a contract) so the agreement is clearly documented and understood.

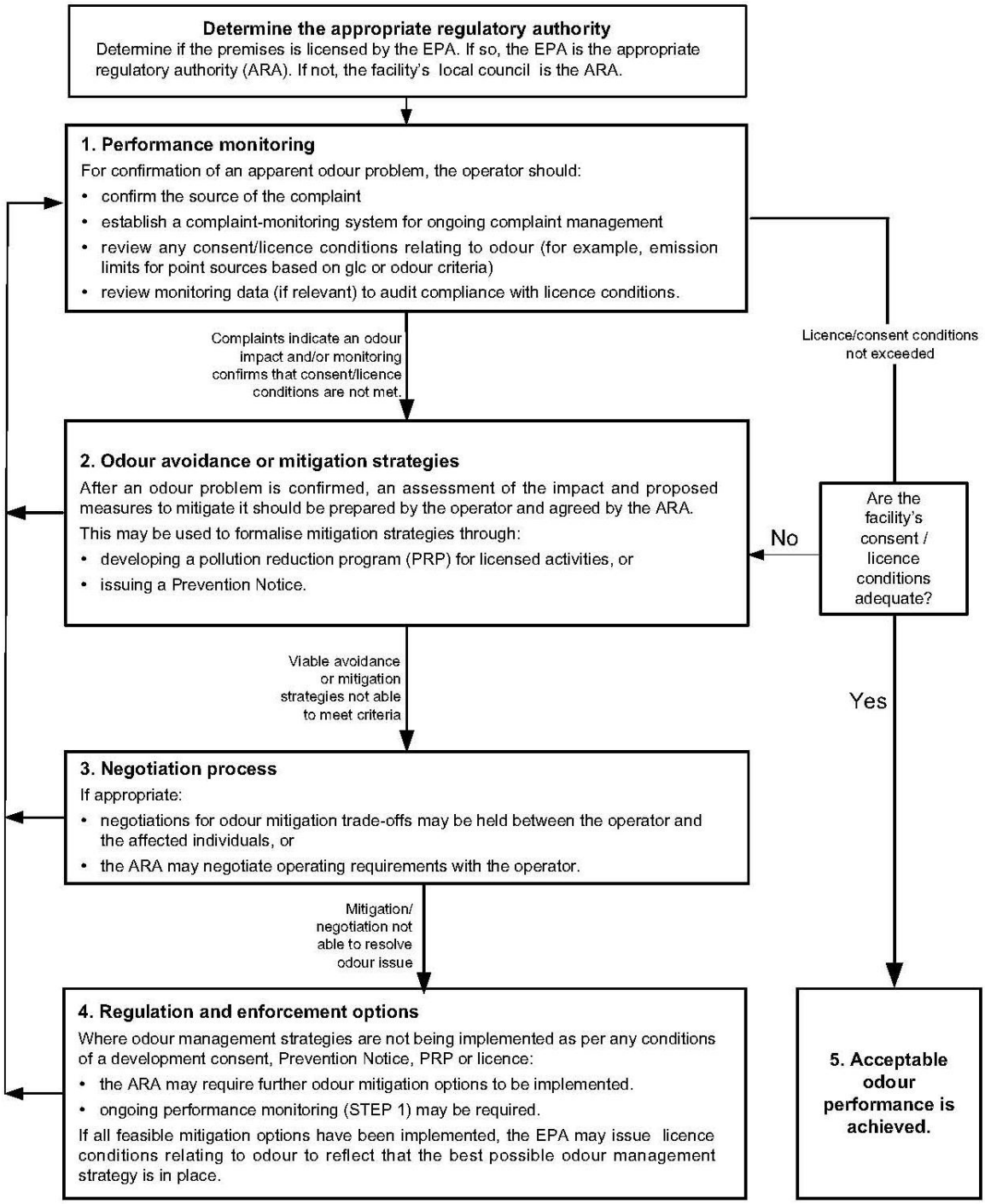

Figure 3-1: Odour impact assessment procedure stipulated by the New South Wales Environmental Protection Agency for existing facilities (NSW EPA, 2001)

3.2 Other Polluting Sources in the Area

Based on satellite imagery and a site visit; the following surrounding sources of air pollution have been identified in the area:

- Vehicle emissions
- Industries such as:
  - Mondi Paper Mill
  - Engen Refinery
  - Sapref refinery
- Landfill site

3.2.1 Vehicle emissions

Traffic volume is high within the Merebank and Jacob's Commercial area and vehicle emissions play a significant role in the contribution to Air Pollution within the area**.** Vehicles are a major source of criteria and hazardous air pollutants such as; NOx,CO, CO_2, HCs, SO_2, Particulate matter, Volatile organic matter and lead (Pb). Light petrol motor vehicles not equipped with pollution control devices have the highest exhaust emissions during acceleration, followed by deceleration and idling cycles. Frequent cycle changes characteristic of congested urban traffic patterns thus tend to increase pollutant emissions. At higher cruise speeds HC and CO emissions decrease, while NO_x and CO_2 emissions increase. Emissions from diesel-fuelled vehicles include particulate matter, NO_x, SO_2, CO and HC, the majority of which occurs from the exhaust. Operating at higher air-fuel ratios (about 30:1 as opposed to 15:1 characteristic of petrol-fuelled vehicles with electronic fuel injection engines), diesel-powered vehicles tend to have low HC and CO emissions, despite having considerably higher particulate emissions.

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Particulate emissions from petrol-driven vehicles are usually negligible. Such emissions when they do occur would result from unburned lubricating oil, and ash-forming fuel and oil additives. Higher particulate emissions are associated with diesel-powered vehicles. Particulates emitted from diesel vehicles consist of soot formed during combustion, heavy HC condensed or adsorbed on the soot and sulphates. In older diesel-fuelled vehicles the contribution of soot to particulate emissions is between 40% and 80%. The black smoke observed to emanate from poorly maintained diesel-fuelled vehicles is caused by oxygen deficiency during the fuel combustion or expansion phase.

Vehicle emissions may be grouped into three different sources, namely;

- Entrainment of dust from road surface due to the wheel action;
- Exhaust fumes,
- Fuel evaporation.

3.2.2 Industries

Paper production is associated with odorous compounds such as hydrogen sulphide and ammonia. Fuels utilised during the process of paper production includes HFO, coal and Sasol gas.

Emissions released from refinery industrial processes (Engen and Sapref) include sulphur dioxide, carbon monoxide, oxides of nitrogen and particulate matter. Through the combustion of various fuels such as coal, paraffin and diesel, various levels of volatile organic compounds or heavy metals are also expected to be released to the atmosphere.

3.2.3 Landfill site

Landfill poses a risk to air, land and groundwater. Landfill gas emissions and fugitive dust are the main concerns arising from landfill operations. Fugitive dust emissions arise from vehicle entrainment on paved and unpaved roads, material handling activities, wind erosion from exposed surfaces and earth moving activities.

Landfill gas is produced by the chemical reactions and microbes acting on the waste and as biodegradable wastes decomposes. Landfill gas is composed of 60% methane and the remainder of carbon dioxide. Varying amounts of nitrogen, oxygen, water vapour, hydrogen sulphide and other contaminants are present in landfill gas. Contaminants are known as “non methane organic compounds” and include toxic chemicals such as benzene, toluene, chloroform, vinyl chloride and carbon tetrachloride. The US-EPA has identified 41 halogenated compounds present in landfill gases such as chlorine, bromine, and fluorine.

The major environmental concern is the influence of landfill gas on climate change as the major components are the greenhouse gases; methane and carbon dioxide.

3.3 Sensitive receptors

A sensitive receptor for the purpose of this report is identified as a place or activity which could involuntarily be exposed to odour and air emissions generated from the proposed abattoir operations. Based on this definition the residential, educational and recreational land uses in the area are considered to be sensitive receptors.

For this study, the position of houses/dwellings on the farms was taken off 1:50 000 topographical cadastral maps and verified as far as possible using Google Earth and site visits. Even though the latest editions were used, maps may be out of date and there may be new dwellings and/or some of the existing shown buildings may be derelict.

The area surrounding the waste water treatment work is surrounded by residential communities. Several schools and communities are situated in close proximity to the treatment works.

Other sensitive receptors within the area would be the local fauna and flora. It has been identified that dust settling on the leaves of plants can result in damage to plants and inhalation of dust may result in sickness and associated lung diseases for wildlife and humans which will be present in the vicinity of the treatment works. A more detailed inventory of settlements and sensitive receptors will be obtained on a site visit and with assistance of the public participation specialists working on the project.

3.4 Baseline Air Quality

The eThekwini Municipality conducted continuous monitoring in the Durban South Basin in 2009 as part of the Air Quality Monitoring Programme and management plan. The monitoring network consisted of 12 monitoring stations of which 3 are background concentrations and 5 are meteorological. Priority pollutants which were assessed include; Sulphur dioxide, Nitrogen dioxide, Particulate matter and Total reduced sulphur. Table 3-6 below provides a list of all the monitoring stations and the measured parameters.

Table 3-6: Location of Monitoring stations and parameters measured.

Monitoring station	SO_2	NO_2	PM_{10}	TRS
Prospecton	x			
Southern Works	x	x	x	x
Settlers School	x			x
Ganges School	x	x	x	
Grosvenor	x			
Wenthworth	x	x	x	
Jacobs	x	x		
Ferndale	x	x	x	
Warwick		x		
City Hall		x	x	

3.4.1 Sulphur dioxide

SO_2 is an irritant that is absorbed in the nose and aqueous surfaces of the upper respiratory tract, and is associated with reduced lung function and increased risk of mortality and morbidity. Adverse health effects of SO_2 include coughing, phlegm, chest discomfort and bronchitis.

Figure 3-2 below illustrates the annual trends in SO_2 from 2004 -2009. There is gradual decrease in the annual concentrations of SO_2 since 2004. The monitoring stations with the exception of the 2004 exceedance at the southern works all fell below the annual SO_2 limit of 50 µg/m^3.

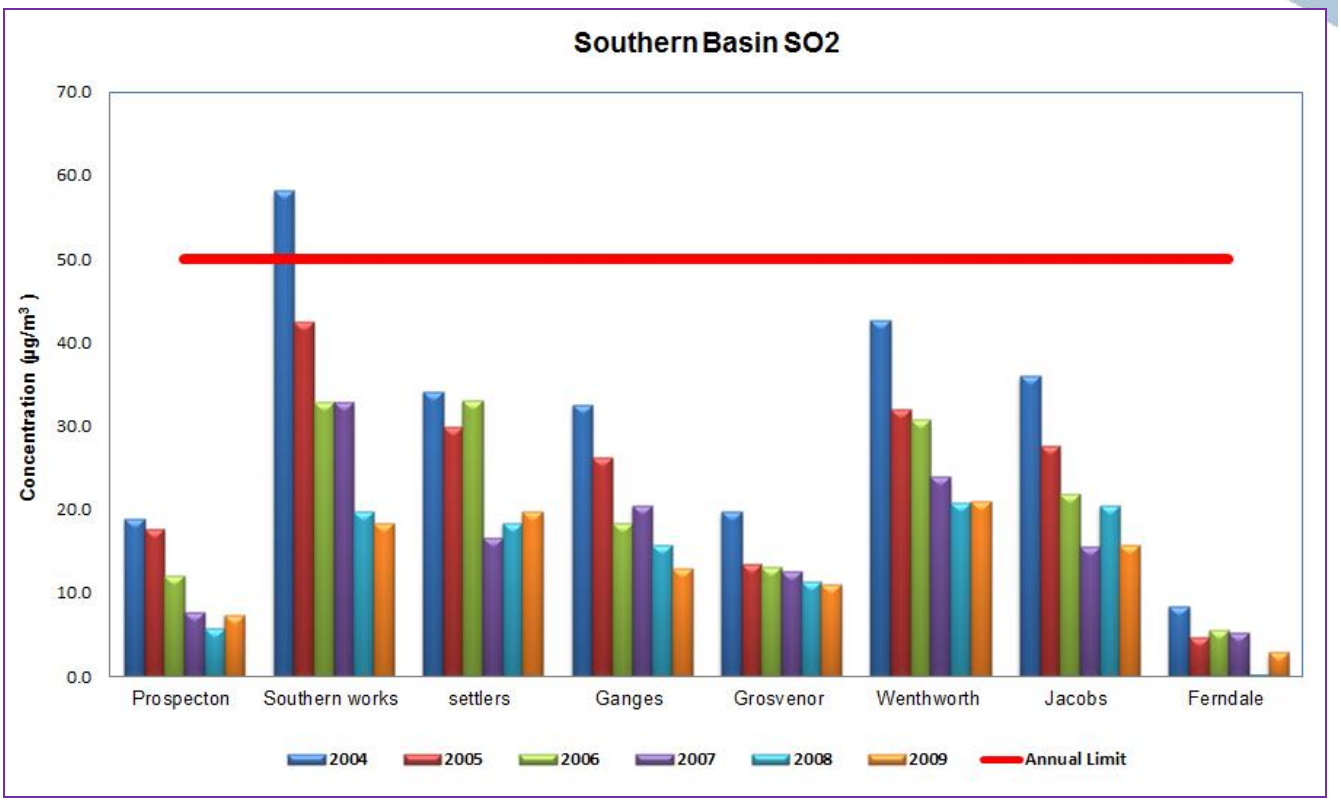

Figure 3-2: Sulphur dioxide concentration (µg/m^3) annual trends (2004 – 2009).

3.4.2 Nitrogen dioxide

Air quality guidelines and standards issued by most other countries and organisations tend to be given exclusively for NO_2 concentrations as NO_2 is the most important species from a human health point of view. NO_2 is an irritating gas that is absorbed into the mucous membrane of the respiratory tract. The most adverse health effect occurs at the junction of the conducting airway and the gas exchange region of the lungs. The upper airways are less affected because NO_2 is not very soluble in aqueous surfaces. Exposure to NO_2 is linked with increased susceptibility to respiratory infection, increased airway resistance in asthmatics and decreased pulmonary function.

Figure 3-3 below illustrates the annual trends in NO_2 from 2004 – 2009. The monitoring station located at the Ganges School exceeded the annual limit of 40 µg/m^3 for NO_2 on 4 occasions in 2004, 2005, 2006 and 2009. The Warwick monitoring station exceeded the annual limit of NO_2 during the 2004 and 2008 monitoring period, while the City Hall and Jacobs Monitoring station exceeded the annual standard in 2006 and 2007 respectively.

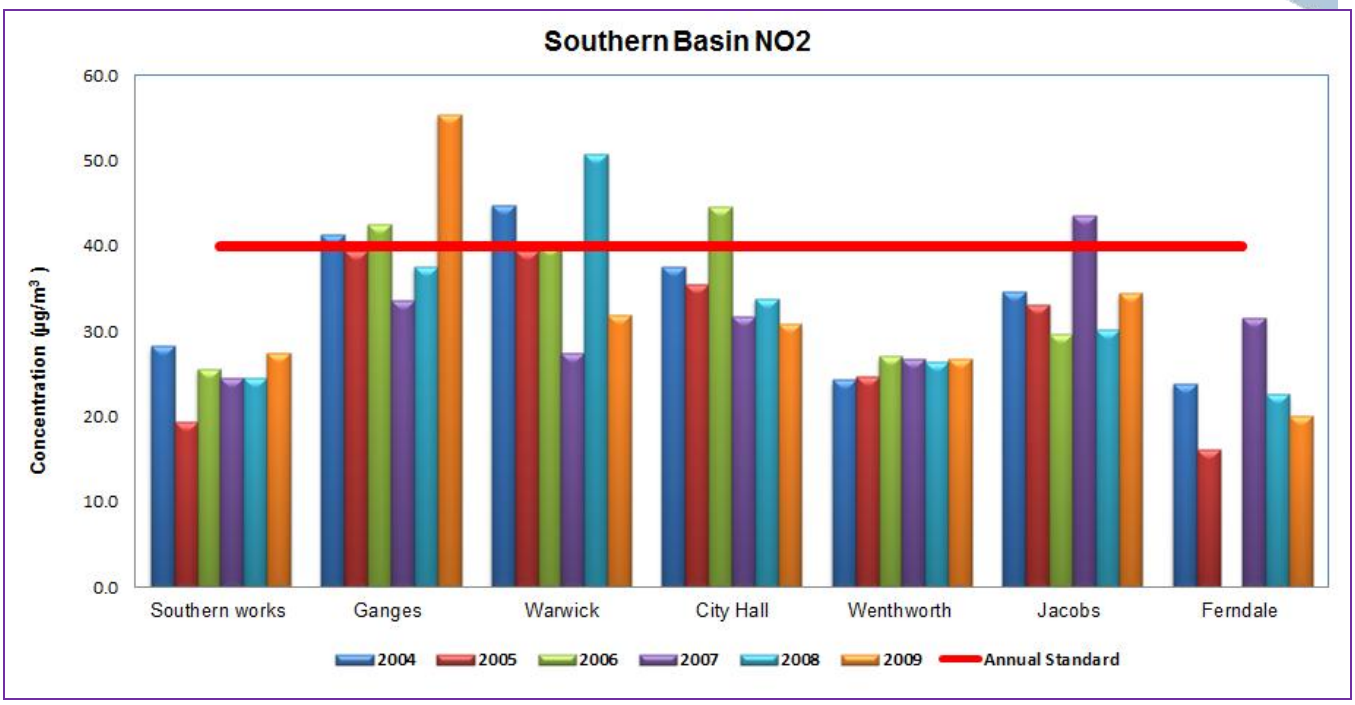

Figure 3-3: Nitrogen dioxide concentration (µg/m^3) annual trends from 2004 – 2009.

3.4.3 Particulate Matter

Particulate matter is the collective name for fine solid or liquid particles added to the atmosphere by processes at the earth's surface. Particulate matter includes dust, smoke, soot, pollen and soil particles (Kemp, 1998). Particulate matter has been linked to a range of serious respiratory and cardiovascular health problems. The key effects associated with exposure to ambient particulate matter include: premature mortality, aggravation of respiratory and cardiovascular disease, aggravated asthma, acute respiratory symptoms, chronic bronchitis, decreased lung function, and an increased risk of myocardial infarction (USEPA, 1996).

Particulate matter represents a broad class of chemically and physically diverse substances. Particles can be described by size, formation mechanism, origin, chemical composition, atmospheric behaviour and method of measurement. The concentration of particles in the air varies across space and time, and is related to the source of the particles and the transformations that occur in the atmosphere (USEPA, 1996).

Figure 3-4 below illustrates the annual trends for particulate matter at the various monitoring stations. As seen from the trends illustrated in the graph below, all monitored data fell below the annual standard of 50 µg/m^3. The highest concentrations (µg/m^3) in PM_{10} were experienced at the Ganges monitoring station.

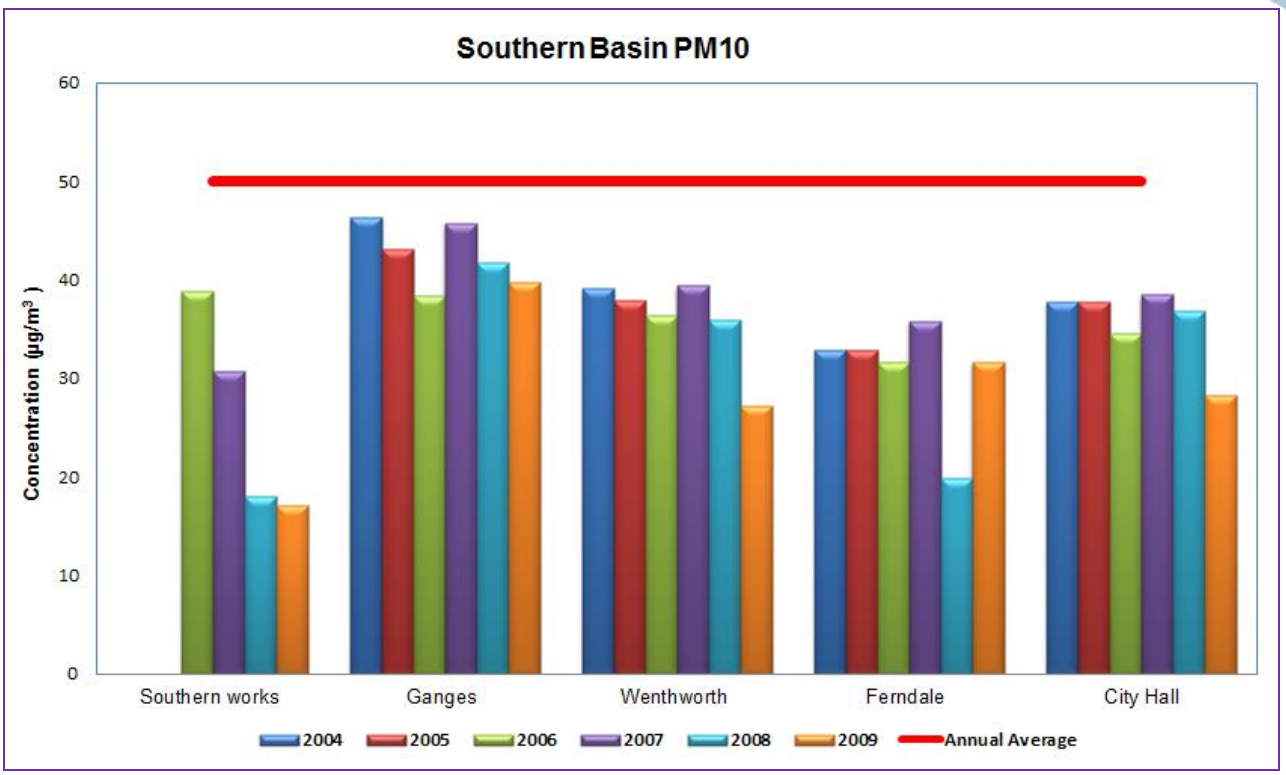

Figure 3-4: Particulate Matter concentration (µg/m^3) annual trends from 2004 – 2009.

3.4.4 TRS (Total Reduced Sulphur)

Total reduced sulphur is not classified as a priority pollutant as thus has no prescribed South African Standards. Use is made of the European Union standards for Hydrogen Sulphide which comprises of 60% of TRS.

Figure 3-5 below illustrates the TRS concentration (ppb) monitored during the 2008 -2009 monitoring period. All monitoring station recorded an annual average below the annual standard of 7.8 ppb.

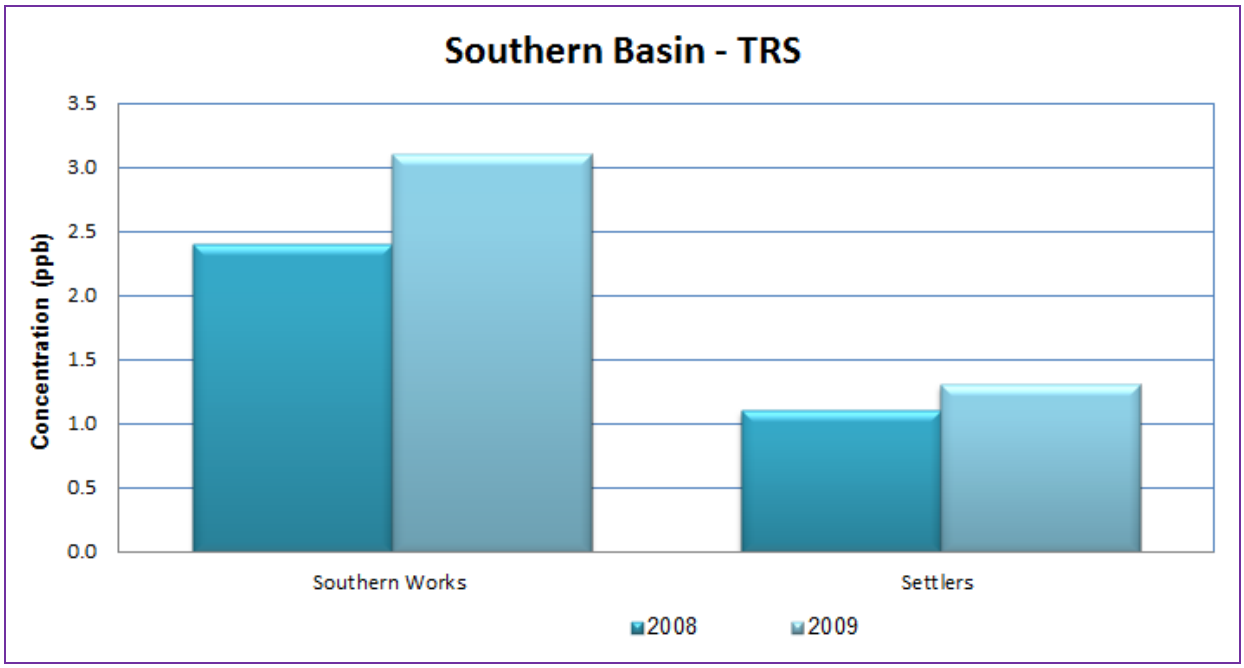

Figure 3-5: TRS concentration (ppb) during the 2008-2009 monitoring period.

4 DESCRIPTION OF POTENTIAL IMPACTS ASSOCIATED WITH ACTIVITY

The scoping impact assessment phase of the investigation assesses the potential impacts that the upgrades will have in the surrounding areas.

This Section of the report outlines the potential impacts with the introduction of the waste water treatment works. To clearly detail the potential impacts in odorous and ambient ground level concentrations, only operational emissions will be included in the final evaluation. The upgrade/construction and decommissioning phases of the operation can only be qualitatively addressed due to the variability and unpredictable nature of the construction operations on site, and initial details are provided in the subsections to follow.

4.1 Construction/ Upgrade Impacts

Construction is a source of dust emission which has a temporary impact on the local air quality. Infrastructure and road construction are the two types of construction activity with high emission potentials. The emissions associated during the construction of a building or road can be associated with land clearing, drilling and blasting, ground excavation and depending on the level of activity, the specific operation and the prevailing meteorological conditions. It has been noted that large quantities of the emissions is generated due to the traffic movement of equipment across temporary roads and around the construction site (USEPA, 1996).

The temporary nature of construction activities is what distinguishes it from other fugitive sources present within the locality. Emissions from construction activities are expected to have a definitive start and end period and will vary depending on the various construction phases. In contrast to other fugitive sources, here the emissions occur in a steady state or follow a discernible pattern. The quantity of dust emissions from construction activities is proportional to the area of land under construction (USEPA, 1996).

The impact on air quality and air pollution of fugitive dust is dependent on the quantity and drift potential of the dust particles (USEPA, 1996). Large particles settle out near the source causing a local nuisance problem. Fine particles can be dispersed over much greater distances. Fugitive dust may have significant adverse impacts such as reduced visibility, soiling of buildings and materials, reduced growth and production in vegetation and may affect sensitive areas and aesthetics. Fugitive dust can also adversely affect human health.

The following component of the environment which may be impacted upon during the upgrades at the Southern Waste Water Treatment Works includes:

- The ambient air quality
- Local residents and neighbouring communities
- employees
- The surrounding environment and possible the fauna and flora.

Because construction is of a temporary nature, it is recommended that mitigation/ control measures be put in place to limit the impacts on the local air quality. Wet suppression and wind speed reduction are common methods used to control open dust sources at construction sites.

- **Actions to be taken during the upgrades**
  - Replace the sea outfall pipe above high f level with approximately 70 m of 100 ND HDPE pipe onshore
  - Upgrade existing pump stations including “low lift” pump station which has a capacity of approximately 215 Ml/day under pump discharge.

- Construct a 2nd overflow dam before the outfall with a capacity of 23 Ml;
- Construct minor new road works;
- Refurbish and upgrade interconnecting pipework on site.

- **Preliminary Treatment**
  - Convert the grit pump to airlift at the inlet works (de-gritters);
  - Refurbish and equip raw sludge pump station with new pump

- **Primary Sedimentation**
  - Open up the old channels to primary settlement tanks and install a side splitter weir;
  - Refurbish concrete joints and exposed aggregates on all diffused channels and primary settlement tanks;
  - Install flow measurement at the primary settlement tanks;
  - Refurbish/ replace bridges for primary settlement tanks;
  - Remedial concrete works on channels and primary settlement tanks;
  - Conditional assessment of feed pipes

- **Sludge Processing**
  - Refurbish existing primary, secondary digesters, gas holders and thickeners;
  - Construct two new primary digesters, a new secondary digester and a new thickener;
  - Establish a new sludge drying facility;
  - Install additional primary sludge screen and hydro-clones before thickeners;
  - Install new burners, heating pumps and circulation pumps;
  - Install four new filter belt presses complete with all dosing equipment and pumps;
  - Establish supernatant liquor return flow pipeline and pump station.

- **Electrical Work**
  - Install a new medium – voltage cable network;
  - Upgrade communications on site;
  - Install new transformers and switch gear;
  - Upgrade certain existing motor control centre (MCC) panels.

4.2 Operational Impacts

A qualitative assessment of the operational impacts is discussed in the section below. VOCs are emitted from waste water treatment works during the waste water collection, treatment and storage systems through volatization of organic compounds at the liquid surface. Emissions can occur by diffusive or convective mechanism or both. Diffusion occurs when organic concentrations at the waster surface are much higher than ambient concentrations. The organics volatize or diffuse into the air in an attempt to reach equilibrium between the aqueous and vapour phases. Convection occurs when air flows over the water surface, sweeping organic vapors from the water surface into the air. The rate of volatization relates directly to the speed of air flow over the water surface.

Other factors that can affect the rate of volatization includes waster water surface area, temperature and turbulence, waste water retention time in the system; the depth of the waste water in the system; the concentration of organic compounds in the waste water and their physical properties such a volatility and diffusivity in water.

The emissions that are released during operation of a waste water treatment works (WWTW) are namely; odour and aerosols. Airborne pathogens are also released during the mechanical processes of the WWTW such as aeration and denitrification. VOC are emitted from the waste water collection, treatment and storage systems through volatisation of organic compound at the liquid surface. Bioaerosols are released from the processing units and defined as airborne particles that are organic in nature. Bioaerosols are more of a concern for the operators at the WWTW and does not impact beyond the vicinity of the processing units.

Odour is however the most noticeable form of pollution from the public perspective. It occurs during specific processes such as cleaning of screens, emptying of sewage tanks and when the sewage sludge turns septic during stockpiling of waste. Compounds contributing to the smell of waste water arise from the original composition of the sewage, the biochemical changes which take place during treatment and the additions of chemical to the sewage as part of the treatment process.

The operating conditions and maximum capacity of the WWTW are important. Overloading, operational failures and maintenance backlogs would result in substandard effluent that is released back into the environment.

The EIA impact assessment modelling will aim to deal with the potential air quality impacts which could result due to the proposed operations at the Southern Waste water treatment works. Details regarding the source characteristic will be obtained from site layout plans and process specific information provided and a questionnaire filled in by the client. Such information relates to the activities carried out on site. Once all site layout plans and final geotechnical works are complete, site specific information should then be sufficient for dispersion modelling and will be included in the EIA report. More information pertaining to the operational impacts will be available at the EIA stage.

4.3 Decommissioning impacts

The decommissioning phase is associated with activities related to the demolition of infrastructure and the rehabilitation of disturbed areas. The total rehabilitation will ensure that the total area will be a free draining covered with topsoil and grassed. The following activities are associated with the decommissioning phase (US-EPA, 1996):

- Existing buildings and structures demolished, rubble removed and the area levelled;
- Remaining exposed excavated areas filled and levelled using overburden recovered from stockpiles;
- Topsoil replaced using topsoil recovered from stockpiles; and
- Land and permanent waste piles prepared for re-vegetation.

Possible sources of fugitive dust emission during the closure and post-closure phase include:

- Smoothing of stockpiles by bulldozer;
- Grading of sites;
- Transport and dumping of overburden for filling;
- Infrastructure demolition;
- Infrastructure rubble piles;
- Transport and dumping of building rubble;
- Transport and dumping of topsoil; and
- Preparation of soil for re-vegetation – ploughing and addition of fertiliser, compost etc.

Exposed soil is often prone to erosion by water. The erodability of soil depends on the amount of rainfall and its intensity, soil type and structure, slope of the terrain and the amount of vegetation cover (Brady, 1974). Re-vegetation of exposed areas for long-term dust and water erosion control is commonly used and is the most cost-effective option. Plant roots bind the soil, and vegetation cover breaks the impact of falling raindrops, thus preventing wind and water erosion. Plants used for revegetation should be indigenous to the area, hardy, fast-growing, nitrogen-fixing, provide high plant cover, be adapted to growing on exposed and disturbed soil (pioneer plants) and should easily be propagated by seed or cuttings.

4.4 Plan of Study

The proposed methodology which will be followed during the air quality impact assessment phase is provided as follows:

- Determine the atmospheric dispersion potential for the area being assessed.
- In order to assess the possible cumulative air quality impacts, monitored ambient and meteorological data will be sourced for the area under investigation.
- If there is no ambient monitored data available, a qualitative assessment will be undertaken which will evaluate the possible impacts of other polluting sources within the area.
- Information gaps in the data provided will be identified.

An assessment of the operational phases of the proposed project will be undertaken by evaluating (where possible) both fugitive and point source emissions. Pollutants that will be assessed are from the waste water treatment activties.

Emission rates and source characteristics obtained from the client will be input into the AerMod View dispersion model to predict the off-site air quality impacts. The model used in the estimation of impacts arising from the proposed activities has an uncertainty which is equal to 2, this it is possible for the results to be over predicting by double or under predicting by half. It is therefore recommended that monitoring to be carried out at the proposed mine during operations to confirm the modelled results and to ensure legal standards are maintained.

An assessment of compliance will be conducted using available health risk screening levels obtained for the pollutants identified. Comparison will be made to both locally and internationally available health risk levels for these pollutants.

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