ATMOSPHERIC IMPACT REPORT

In support of the Ray Nkonyeni Municipality to conduct an environmental assessment process and Atmospheric Emission License (AEL) application for the proposed Izotsha Crematorium located in Port Shepstone, KwaZulu-Natal

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Report Details

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EXECUTIVE SUMMARY

Isolendalo Environmental Consulting has been appointed by the Ray Nkonyeni Municipality to conduct an environmental assessment process and Atmospheric Emission License (AEL) application for the proposed installation of a cr`emator at the Izotsha Crematorium located in Ray Nkonyeni, KwaZulu-Natal. The cremator will be used for the incineration of human remains. This is a greenfield project. The facility will be classified as a Sub-category 8.2 (Crematoria and Veterinary Waste Incineration) Listed Activity. An Atmospheric Impact Report (AIR) (as contemplated in Section 30 of the National Environmental Management: Air Quality Act 39 of 2004) is required for the above-mentioned project. uMoya-NILU Consulting has in turn been appointed by Isolendalo Environmental Consulting to conduct the AIR aspect of the project.

The Izotsha Crematorium will be located in an agricultural area within the Ray Nkonyeni Municipality of the iLembe District. The nearest farm house, a sensitive receptor, is located approximately 1.3 km to the north-east.

European Environmental Agency emission factors are used to estimate emissions of particulates (PM_{10} and $PM_{2.5}$), oxides of nitrogen (NO_X), sulphur dioxide (SO_2) and carbon monoxide (CO) from the proposed new cremator at the Izotsha Crematorium, for the maximum design case of cremation of 11 bodies/day (maximum design) to account for maximum emissions from the cremator. However, it is envisaged that 1.02 bodies/day (actual) will be cremated at Vlaksruit Crematorium. It is evident that resultant emission rates are relatively low, even with no emission control devices in place, as presented in Table A below.

Table A: Point source emission rates, based on European Environmental Agency emission factors for normal operating conditions

Pollutant	Emission Scenarios					
	Actual (g/s)	Max. Design (g/s)	Actual (kg/day)	Max. Design (kg/day)	Actual (kg/y)	Max. Design (kg/y)
SO_2	1.33E-03	1.44E-02	0.12	1.24	42.07	453.70
NO_x	9.74E-03	1.05E-01	0.84	9.08	307.15	3312.38
CO	1.65E-03	1.78E-02	0.14	1.54	52.12	562.10
PM_{10}	4.10E-04	4.42E-03	0.04	0.38	12.92	139.32
$PM_{2.5}$	4.10E-04	4.42E-03	0.04	0.38	12.92	139.32
Pb	3.54E-04	3.82E-03	0.03	0.33	11.17	120.45
Hg	1.77E-05	1.91E-04	0.00	0.02	0.56	6.02

From Table A, it is clear that the pollutant emitted in the largest quantity is NO_x at 3312.38 kg/y for the maximum design scenario. For the actual or normal operational scenario, NO_x emissions are estimated at a relatively low 307.15 kg/y. The estimated emissions are generally low, especially for the actual or normal operation scenario and in comparison with emissions from large point sources such as refineries, power stations and pulp and paper plants. However, the impact of these emissions on ground level can only be estimated through dispersion modelling.

The DEA recommended and USEPA-approved SCREEN3 dispersion model is used to assess the effects and potential consequences of uncontrolled emissions from the proposed new cremator in the surrounding environment. Modelled ambient concentrations (Table B) of PM_{10}, $PM_{2.5}$, NO_2, SO_2 and CO are considerably lower than the respective health-based ambient air quality standards and the highest concentrations are predicted 250 m to 350 m from the cremator.

Table B: Maximum predicted ambient concentrations for the proposed new cremator

Pollutant	Ambient Concentration (μg/m³)		
	1-hour	**24-hour**	**Annual Average**
PM_{10}	-	0.77	0.15
$PM_{2.5}$	-	0.77	0.15
NO_2	46.04	-	3.68
SO_2	6.31	2.52	0.50
CO	-	5.47	0.62
Pb	-	-	0.134

The significance rating for impacts during construction and decommissioning (with or without mitigation) is low, implying that the potential impact is negligible and should not have a negative influence on the decision regarding the proposed development. Similarly, the significance rating for impacts during operations (with or without mitigation) is very low, implying that the potential impact is very small and should not have a negative influence on the decision regarding the proposed development. From an air quality perspective, it is therefore recommended that the proposed project should go ahead.

GLOSSARY OF TERMS AND ACRONYMS

AEL	Atmospheric Emission License
AIR	Atmospheric Impact Report
DEA	Department of Environmental Affairs
g/s	Grams per second
kPa	Kilo Pascal
MES	Minimum Emission Standards
mg/hr	Milligrams per hour refers to emission rate, i.e. mass per time
mg/Nm^3	Milligrams per normal cubic meter refers to emission concentration, i.e. mass per volume at normal temperature and pressure, defined as air at 20^{o}C (293.15 K) and 1 atm (101.325 kPa)
NAAQS	National Ambient Air Quality Standards
NEM-AQA	National Environment Management: Air Quality Act, 2004 (Act No. 39 of 2004)
NEMA	National Environmental Management Act, 1998 (Act No. 107 of 1998)
USEPA	United States Environmental Protection Agency
µm	Micro meter (1 µm = 10^{-6} m)
WHO	World Health Organization

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1. ENTERPRISE DETAILS

1.1 Enterprise Details

The enterprise details relating to the Izotsha Crematorium located in Ray Nkonyeni are listed in Table 1.

Table 1: Enterprise details

Entity Name:	Izotsha Crematorium
Trading as:	
Type of Enterprise, e.g. Company/Close Corporation/Trust, etc.:	
Company/Close Corporation/Trust Registration Number (Registration Numbers if Joint Venture):	
Registered Address:	10 Corner Street, Port Shepstone, 4240
Postal Address:	P O Box 5, Port Shepstone, 4240
Telephone Number (General):	039 688 2000
Fax Number (General):	
Company Website:	
Industry Type/Nature of Trade:	Cremator for human remains
Land Use Zoning as per Town Planning Scheme:	
Land Use Rights if outside Town Planning Scheme:	
Responsible Person:	Max Mbili
Emissions Control Officer:	
Telephone Number:	
Cell Phone Number:	
Fax Number:	
Email Address:	mm@mm.gov.za
After Hours Contact Details:	

1.2 Location and Extent of the Plant

The site information relating to the Izotsha Crematorium located in Ray Nkonyeni are listed in Table 2.

Table 2: Site information

Physical Address of the Licensed Premises:	
Description of Site:	
Property Registration Number (Surveyor-General Code):	
Coordinates (latitude, longitude) of Approximate Centre of Operations (Decimal Degrees):	Latitude: -30.792297° Longitude: 30.398575°
Coordinates (UTM) of Approximate Centre of Operations:	Easting: 251074.56 m E Northing: 6590522.24 m S
Extent (km²):	
Elevation Above Mean Sea Level (m):	163
Province:	KwaZulu-Natal
District/Metropolitan Municipality:	Ugu District Municipality
Local Municipality:	Ray Nkonyeni Municipality
Designated Priority Area (if applicable):	Not Applicable

Description of surrounding land-use (within 5 km radius)

The Izotsha Crematorium will be located in the Izotsha Memorial Park within the Ray Nkonyeni Municipality of the Ugu District. The Ray Nkonyeni Municipality proposes to construct the crematorium on a 7154.3 m^2 piece of land in the outskirts of Shelley Beach, which primarily serves as a grave site which is also suitable for development as a crematorium. The surrounding land use is primarily agricultural and residential, which comprises of residential holdings. The Izotsha Crematorium is surrounded primarily by sugar cane farms to the north, south and west and residential settlements to the east. The relative location of the crematorium is shown in Figure 1. Approximately 750 m to the south-east is Shelley Beach Shopping Centre. Residential settlements of Shelley Beach are located >750 m to the east and south-east of the crematorium up to the sea. St. Michaels-on-Sea is located 3.5 km to the south south-east. A farmhouse is located approximately 650 m to the east while several other farmhouses are located further to the east, however, they are sparsely distributed. Other residential settlements are located further to the east, close to 5 km away, and these include Gamalakhe, Bhethani and Nsangwini.

The Norwegian Settlers Church is located approximately 4 km to north. The two residential areas that have been selected as sensitive receptors for the study area are Shelley Beach and St. Michaels-On-Sea. These, together with other sensitive receptors are listed in Table 15, in terms of distance and direction from the crematorium.

Figure 1: Relative location of the Izotsha Crematorium located in Ray Nkonyeni, to the surrounding residential and industrial areas, within a 5 km radius around the site (Google Earth, 2019)

1.3 Atmospheric Emission License (AEL) and Other Authorisations

The Izotsha Crematorium is not in possession of an Atmospheric Emissions License (AEL) or any other authorisations (Table 3).

Table 3: Current authorisations related to air quality

Atmospheric Emission License	Date of Registration Certificate	Listed Activity Subcategory	Category of Listed Activity	Listed Activity Process Description
No record				

2. NATURE OF THE PROCESS

2.1 Listed Activity or Activities

As a measure to reduce emissions from industrial sources and to improve ambient air quality, Listed Activities and associated Minimum Emission Standards (MES) were published in 2010 in Government Notice 248 (DEA, 2010) and revised in Government Notice 893

(DEA, 2013), and again in Government Notice 1207 of 31 October 2018 (DEA, 2018). The processes at the Izotsha Crematorium include one Listed Activity. The Listed Activity with the respective MES is shown in Table 4. The proposed new cremator will be used for the incineration of human remains.

According to the MES, existing industrial facilities must comply with the MES for 'new plants' by 1 April 2020 (Table 5). New facilities must immediately comply with the MES for new plants. As such, the Izotsha Crematorium must comply with the MES for new plants when the proposed new cremator is commissioned.

Table 4: Details of the Listed Activities carried out at the Izotsha Crematorium according to GN 248 (DEA, 2013)

Category of Listed Activity	Sub-category of the Listed Activity	Description of the Listed Activity
Category 8: Thermal Treatment of Hazardous and General Waste	Sub-category 8.2: Crematoria and Veterinary Waste Incineration	Cremation of human remains, companion animals (pets) and the incineration of veterinary waste[a]

a The proposed new cremator will be used for the incineration of human remains

Table 5: Minimum Emission Standards for Subcategory 8.2 Listed Activities according to GN 248 (DEA, 2013)

Substance or mixture of substances		Plant Status	Minimum Emission Standards (mg/Nm^3) under normal conditions of 273 Kelvin and 101.3 kPa.
Common name	**Chemical symbol**		
Particulate matter	N/A	New	40
		Existing	250
Carbon monoxide	CO	New	75
		Existing	150
Oxides of nitrogen	NO_x expressed as NO_2	New	500
		Existing	1000
Mercury (Applicable to human cremation only) [a]	Hg	New	0.05
		Existing	0.05

a Mercury, which is applicable to human cremation only, will not be considered in this assessment as there are no ambient air quality standards in place for mercury

2.2 Process Description

The Ray Nkonyeni Municipality proposes the installation of a new JTA BA2 cremator, with a recommended load capacity of a 150 kg/h human body and a maximum load capacity of 200 kg/h. On this basis, a total of 5 to 8 cremations per 8 hour or 8 to 11 cremations per 12 hours could be handled. However, the initial estimate by the Ray Nkonyeni Municipality is that only 372 cremations will be performed per year; which equates to just more than a body a day. The operating hours of the crematorium will be 08:15 to 16:30. However, this may vary depending on the number of bookings.

The cremator is equipped with 2 gas burners. The primary chamber will operate between 750 and 900 °C while the secondary chamber will operate between 800 and 1 100 °C. Using gas fuel, the cremator will have a maximum power output of 830 kW. The normal gas usage, in this case liquid petroleum gas (LPG), will be approximately 3 840 l/day. The project has made provision for 2 x 20 000 litre gas storage tanks which will likely be installed underground due to the explosive/combustible nature of LPG.

The cremators will be equipped with stacks with a diameter of 600 mm and a height of 11.4 m to ensure effective dispersion of pollutants produced during the cremation process.

The incineration process will be carried out by placing the human remains in the proposed new cremator, adding LPG and igniting the LPG using an electrical burner. The resulting ash is placed in containers and disposed of at the municipal landfill site or handed to the family of the deceased.

The process description is based on controlled-air incineration, which is the most widely used cremator technology, and now dominates the market for new systems at cemeteries. This technology is also known as starved-air incineration, two-stage incineration, or modular combustion. Figure 2 presents a typical flow diagram of the cremation process.

Combustion in controlled air cremators occurs in two stages. In the first stage, human remains are fed into the primary, or lower, combustion chamber, which is operated with less than the stoichiometric amount of air required for combustion. Combustion air enters the primary chamber from beneath the cremator hearth (below the burning bed of waste). This air is called primary or underfire air. In the primary (starved-air) chamber, the low air-to-fuel ratio dries and facilitates volatilization of the body, and most of the residual carbon in the ash burns. At these conditions, combustion gas temperatures are relatively low (750 to 980 °C).

In the second stage, excess air is added to the volatile gases formed in the primary chamber to complete combustion. Secondary chamber temperatures are higher than primary chamber temperatures, typically 800 to 1 100 °C. Depending on the heating value and moisture content of the waste, additional heat may be needed. This can be provided by auxiliary burners located at the entrance to the secondary (upper) chamber to maintain desired temperatures.

The feed and ash removal can be manual or automatic, depending on the unit size and options purchased. Because of the low air addition rates in the primary chamber, and corresponding low flue gas velocities (and turbulence), the amount of solids entrained in the gases leaving the primary chamber is low. Therefore, the majority of controlled air cremators do not have add-on gas cleaning devices. Several air pollutants are emitted from the incineration process due to the combustion of fuel and waste material within the cremator. Emission rates depend on the design of the cremator, combustion temperature, gas retention time, duct design, duct temperature and any control devices.

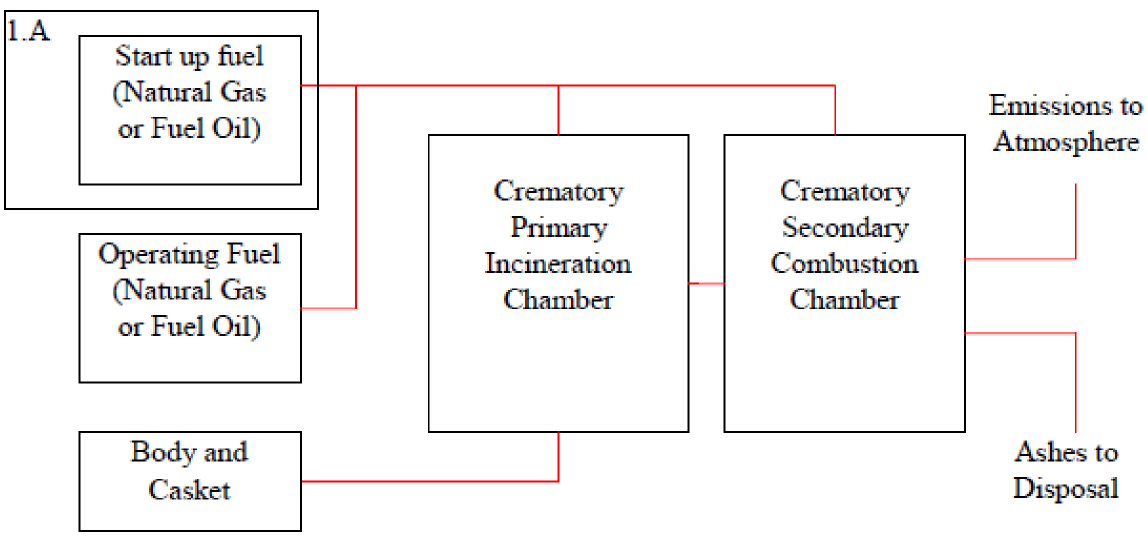


Figure 2: Flow diagram of the cremation process

2.3 Unit Processes

The unit processes at the Izotsha Crematorium located in Ray Nkonyeni are listed in Table 6.

Table 6: Unit processes at the Izotsha Crematorium located in Ray Nkonyeni

Name of the Unit Process	Unit Process Function	Batch or Continuous
Cremator	Incineration of human remains	Batch

3. TECHNICAL INFORMATION

3.1 Raw Materials Used

The Izotsha Crematorium is not a production facility, but a facility where human remains are disposed by incineration. Therefore, the reporting of "raw material type" and "design consumption rate" (Table 7) has been replaced by "material type" and "number of bodies incinerated", respectively.

Table 7: Design burn rate of cremator

Material Type	No. of Bodies Incinerated - Design	No. of Bodies Incinerated - Expected	Units
Human remains	8 – 11	1.02	Per day

No by-products are produced at the Izotsha Crematorium. Materials and quantities used in energy sources at the crematorium are presented in Table 8.

Table 8: Materials and quantities used in energy sources

Materials for Energy Source	Actual Consumption Rate (Quantity)	Units (quantity/period)
LPG	20- 50	kg/hour

3.2 Appliances and Abatement Equipment Control Technology

Due of the low air addition rates in the primary chamber, and corresponding low flue gas velocities (and turbulence), the amount of solids entrained in the gases leaving the primary chamber is low. Therefore, the majority of controlled air cremators do not have add-on gas cleaning devices. There are no air pollution control and abatement technology currently proposed at the Izotsha Crematorium (Table 9).

Table 9: Appliances and abatement equipment and control technology

Appliance Name	Appliance Type/Description	Appliance Function/Purpose
No air pollution control and abatement technology is currently proposed		

4. ATMOSPHERIC EMISSIONS

4.1 Point Source Parameters

The location of the proposed new cremator stack and stack parameters are provided in Table 10.

Table 10: Location of proposed new cremator stack and stack parameters

Point source name	Point source coordinates *	Height of release above ground (m)	Height above nearby building (m)	Diam. at stack tip/vent exit (m)	Actual gas exit temp. (°C)	Actual gas volumetric flow (m^3/hr)	Actual gas exit velocity (m/s)	Type of emission (continuous/ batch)
Cremator Stack	Latitude: -30.792297° Longitude: 30.398575°	11.4	>3	0.6	To be determined (177 °C used in dispersion modelling)	To be determined	To be determined (2.5 m/s used in dispersion modelling)	Batch

* Decimal degrees

4.2 Point Source Maximum Emission Rates (Normal Operating Conditions)

Stack emission testing is generally considered to be the most accurate method for estimating emissions, as it entails the direct measurement of pollutant concentrations. In the absence of emission testing data, the alternate method is to use an activity number (in this case, the number of bodies cremated in a certain period) and apply appropriate emission factors to estimate emissions. This section describes the methodology used to estimate emission rates of particulates (PM_{10} and $PM_{2.5}$), NO_x, SO_2 and CO resulting from emissions from the proposed new cremator.

The emissions from the proposed new cremator at the Izotsha Crematorium will be estimated for two incineration scenarios:

1. Actual case of 1.02 bodies per day
2. Maximum design case of 11 bodies per day

Emission Factor Method

An emissions factor is a representative value that relates the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. These factors are usually expressed as the weight of pollutant emitted divided by a unit weight, volume, distance, or duration of the activity emitting the pollutant (e.g., kg of particulate emitted per body burned). Such factors facilitate estimation of emissions from various sources of air pollution. In most cases, these factors are simply averages of all available data of acceptable quality, and are generally assumed to be representative of long-term averages for all facilities in the source category. The general equation for emissions estimation is:

$$E = A \times EF \times (1 - ER/100) \quad (1)$$

Where:
E = emissions;
A = activity rate;

EF = emission factor; and
ER = overall emission reduction efficiency (%)

The primary pollutants from the cremation of human remains are particulate matter, oxides of nitrogen (NO_x), sulphur dioxide (SO_2), carbon monoxide (CO), volatile organic compounds (VOC), mercury, other heavy metals organics and some persistent organic pollutants (POPs). Of these, only particulates (PM_{10} and $PM_{2.5}$), NO_X, SO_2 and CO will be considered in this assessment since these pollutants are classified as priority pollutants in South Africa for which ambient air quality standards are in place. The emission rates of these pollutants depend on the design of the cremator, combustion temperature, fuel retention time, duct design, duct temperature and any control device.

The European Environment Agency developed emission factors within the framework of Corinair (Core Inventory Air Emissions) to specifically estimate emissions from the incineration of human bodies in a crematorium. As pointed out earlier, emission factors generally relate the quantity of pollutants emitted to an activity associated with the source of pollution. In the case of the crematorium, the activity is the number of cremations per year. Emissions increase with an increase in the number of bodies cremated. The municipality estimates that one body a day or seven a week will be cremated when the crematorium reaches its operational peak level.

The key pollutants for which emission factors are available are (SO_2), NO_x, CO, particulate matter less than 10 microns (PM_{10}), particulate matter less than 2.5 microns ($PM_{2.5}$), VOC, lead (Pb), Hg and several other heavy metals. The emission factors proposed by Corinair are presented in Table 11. The study will focus on these key pollutants emitted from crematoria.

Table 11: Emission factors for incineration of human remains

Pollutant	Emission Factor	Unit
SO_2	0.113	kg/body
NO_x	0.825	kg/body
CO	0.140	kg/body
PM_{10}	0.0347	kg/body
$PM_{2.5}$	0.0347	kg/body
Pb	0.0300	mg/body
Hg	0.0015	mg/body

The magnitudes of the emission factors indicate that NO_x is emitted in the largest quantities per body cremated, followed by CO, SO_2 and PM_{10}. The heavy metal emitted in the greatest quantity is Pb, whilst the other heavy metals are emitted in trace amounts. It is assumed that all the NO_x produced is NO_2.

The emission factors for PM_{10} and $PM_{2.5}$ are the same at 0.0347 kg/body; this implies that 100% of all particulate matter smaller than 10 microns are actually smaller than 2.5 microns. The emission factor for Pb of 0.0300 kg/body implies that majority of particulates emitted from the combustion process are Pb.

Point source maximum emission rates for actual case (normal operation) and maximum design case (maximum operation) are provided in Table 12. It is evident that resultant emission rates are relatively low, even with no emission control devices in place.

Table 12: Point source emissions emission rates, based on European Environmental Agency emission factors for normal operating conditions

Pollutant	Emission Scenarios					
	Actual (g/s)	Max. Design (g/s)	Actual (kg/day)	Max. Design (kg/day)	Actual (kg/y)	Max. Design (kg/y)
SO_2	1.33E-03	1.44E-02	0.12	1.24	42.07	453.70
NO_x	9.74E-03	1.05E-01	0.84	9.08	307.15	3312.38
CO	1.65E-03	1.78E-02	0.14	1.54	52.12	562.10
PM_{10}	4.10E-04	4.42E-03	0.04	0.38	12.92	139.32
$PM_{2.5}$	4.10E-04	4.42E-03	0.04	0.38	12.92	139.32
Pb	3.54E-04	3.82E-03	0.03	0.33	11.17	120.45
Hg	1.77E-05	1.91E-04	0.00	0.02	0.56	6.02

It is important at the outset to note that the emissions in Table 12 are reported as emission rates in units of mass over time (kg/y, kg/day and g/s). Reporting in these units is necessary, as the key input into dispersion models are emission rates in units of mass over time. Dispersion modelling is required for any air quality assessment project involving a proposed development as the models can be used to predict ambient air quality using emissions and meteorological data. The estimation of emissions as emission rates are also required for reporting annually to the National Atmospheric Emission Inventory System (NAEIS).

Emission limits, on the other hand, are set in South Africa as emission concentrations in units of milligram per normal cubic meter (mg/Nm^3). Emission concentrations are not calculated but are measured using methods prescribed by legislation. This is relevant to this study as compliance with the emission limits for Subcategory 8.2 listed activities can only be determined once the cremator has been commissioned and is operational. For this study, it suffices to estimate the emission rates, which in turn are used to predict ambient concentrations of pollutants using dispersion models.

From Table 12, it is clear that the pollutant emitted in the largest quantity is NO_x at 3312.38 kg/y for the maximum design scenario. For the actual or normal operation scenario, NO_x emissions are estimated at a relatively low 307.15 kg/y.

Emissions of CO are estimated at 562.10 kg/y for the maximum design scenario and a low 52.12 kg/y for the actual scenario. SO_2 emissions are estimated at 453.70 kg/y for the maximum design scenario and a low 42.07 kg/y for the actual scenario. For PM_{10} and $PM_{2.5}$, emissions are estimated at 139.32 kg/y for the maximum design scenario and 12.92 kg/y for the actual scenario. Emissions of Pb are estimated at a low 120.45 kg/y for the maximum design scenario and an even lower 11.17 kg/y for the actual scenario. Emissions of Hg are estimated at a very low 6.02 kg/y for the maximum design scenario and an even lower 0.56 kg/y for the actual scenario.

The estimated emissions are generally low, especially for the actual or normal operation scenario and in comparison with emissions from large point sources such as refineries, power stations and pulp and paper plants. However, the impact of these emissions on ground level can only be estimated through dispersion modelling.

4.3 Point Source Maximum Emission Rates (Start Up, Shut-Down, Upset and Maintenance Conditions)

A description of start-up, shut-down, upset and maintenance conditions with specific reference to the emissions profile that will be expected for the pollutant/s identified for the specific listed activity is not currently available for the proposed new cremator.

However, as with any combustion device, emissions during start-up are expected to be higher than during normal operation as the cremator will not be functioning at its optimum level. However, start-up takes place over a very short period, resulting in negligible to low impacts on the ambient environment.

Emissions during shutdown are expected to be negligible as the source of combustion, the fuel, will be removed when shutting down the cremator.

It is impractical to quantify emissions during an upset condition as the nature of the upset will vary. Upset conditions could arise from mechanical or electrical failures to the cremator. The cremator will be shut down immediately following an upset condition. Although emission rates will most likely be elevated, the impacts on the receiving environment will be low due to the short period of elevated emissions.

Emissions during maintenance are also expected to be negligible. While the cremator is being maintained, no combustion takes place, therefore no emissions are produced.

4.4 Fugitive Emissions

Emissions are only estimated for the operational phase of the project as emissions from commissioning and decommissioning are considered insignificant. During construction and decommissioning, dust is produced from the movement of construction vehicles and general construction activities (excavating, demolishing, laying concrete, etc.).

The primary fugitive emission source expected from the operational phase at the Izotsha Crematorium are the two LPG storage tanks. Emissions of VOC from storage tanks occur because of evaporative losses of the liquid during its storage and as a result of changes in the liquid level. The emission rates are dependent on whether the tank is of a fixed roof, floating roof or pressure vessel configuration. The LPG storage tank at the Izotsha Crematorium will be of the pressure vessel type. The two significant types of emissions from fixed roof tanks are standing storage losses and working losses. Standing storage loss is the expulsion of vapour from tanks through vapour expansion and contraction, which is the result of changes in temperature and barometric pressure. This loss occurs without any change in liquid level in the tank. The loss from filling and emptying the tank is called working loss. Evaporation during filling operations is a result of an increase in the liquid level in the tank. As the liquid level increases, the pressure inside the tank exceeds the relief pressure and vapours are expelled from the tank. Evaporative loss during emptying occurs when air drawn into the tank during liquid removal becomes saturated with organic vapour and expands, thus exceeding the capacity of the vapour space.

Due to the inherent design of a pressure vessel and despite storing a product of high volatility, fugitive emissions from the LPG storage tanks are expected to be very low. Emissions from storage tanks are therefore not considered in this assessment.

4.5 Emergency Incidents

The only potential source identified for an emergency incident are the LPG storage tanks. A leak in the tank could results in the uncontrolled loss of LPG to the atmosphere and this could pose an explosion risk. However, proper tank design and compliance with maintenance requirements will greatly contribute to minimising this risk.

5. IMPACT OF ENTERPRISE ON THE RECEIVING ENVIRONMENT

5.1 Analysis of Emissions' Impact on Human Health

In order to assess the atmospheric impact of the facility on human health, a dispersion modelling study was undertaken in accordance with the regulations regarding air dispersion modelling specified for regulatory purposes – developed in terms of section 53 of AQA. The impact assessment only takes the emissions of the facility under consideration as well as prevailing ambient air concentrations into account during this assessment. A compliance assessment was undertaken using the National Ambient Air Quality Standards (NAAQS), specifically in residential areas and other areas where human exposure could occur.

This section first provides a background on the prevailing climatic conditions at the Izotsha Crematorium in Ray Nkonyeni in terms of temperature, rainfall and wind; NAAQS; and the current status of ambient air quality in the vicinity of the crematorium. This is then followed by the dispersion modelling procedure, results of the dispersion modelling and an air quality impact assessment.

5.1.1 Prevailing Climatic Conditions

The climate of a location is affected by its latitude, terrain, and altitude, as well as nearby water bodies and their currents. Climates can be classified according to the average and the typical ranges of different variables, most commonly temperature and precipitation. The most commonly used classification scheme was originally developed by Wladimir Köppen.

The temperate climate of the KwaZulu-Natal coast is influenced by the warm Indian Ocean and the relative position and strength of the semi-permanent high-pressure system to the east over the Indian Ocean (Preston-Whyte and Tyson, 1988). The warm ocean controls seasonal and diurnal temperature variations, with a relatively small range in both. The subsiding air associated with the high pressure system results in generally warm and sunny conditions throughout the year. These conditions are interrupted by the passage of coastal lows and cold front systems that move up the coast, often introducing cloudy conditions with strong winds. The frequency of cold fronts varies seasonally and is lowest in summer owing to the southward migration of the high-pressure systems (Diab, 1986).

Meteorological monitoring is not undertaken in the Ray Nkonyeni Local Municipality. The nearest monitoring stations are South African Weather Service's station on the coast at Port

Shepstone and at Paddock, some 16 km inland of Port Shepstone. The meteorology at these stations is considered to be representative of the Ray Nkonyeni Local Municipality coastal and inland regions, respectively. The average monthly maximum, minimum and mean temperatures at Port Shepstone and Paddock are shown in Figure 4.1. The mean daily temperature at Port Shepstone is 20.3 °C, ranging from an average minimum of 16.9 °C to an average maximum of 23.7 °C, while mean daily temperature at Paddock is cooler than Port Shepstone at 18.1 °C, ranging from an average minimum of 13.7 °C to an average maximum of 22.6 °C (SAWS, 1998). The average annual rainfall for Port Shepstone and Paddock is 1 140 mm and 1 271 mm, respectively (SAWB, 1992). Most of the rain occurs in the summer, from late September to March (Figure 4.1), associated with convective storms and occasionally cold fronts. The rains in winter are exclusively associated with the passage of cold fronts.

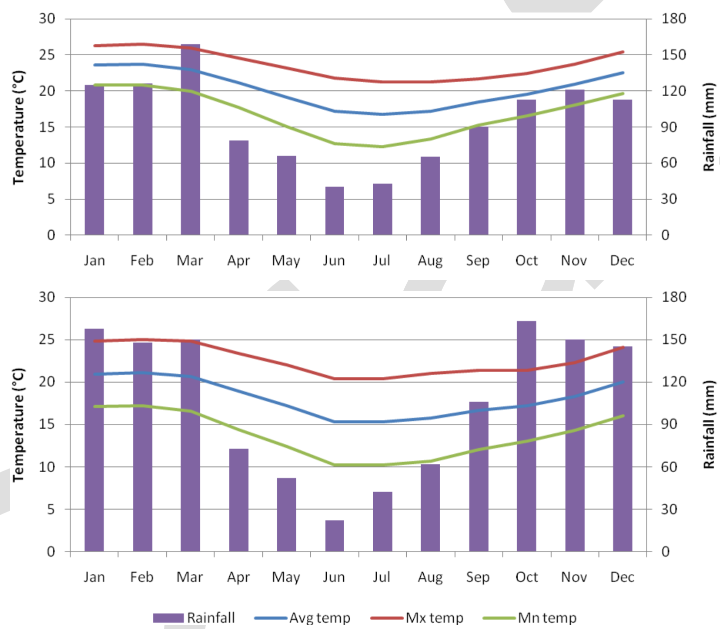
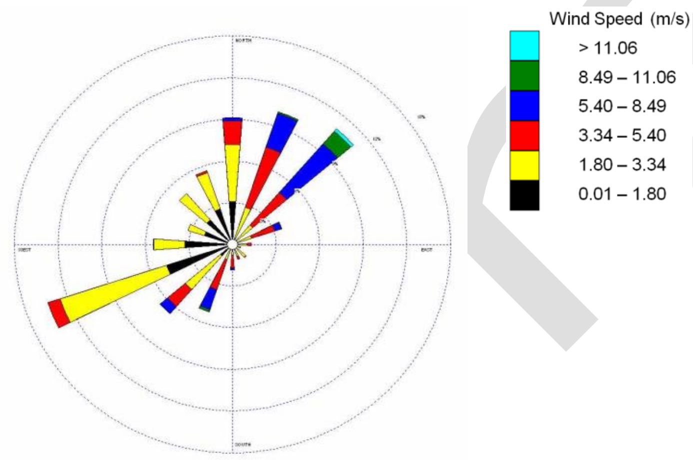


Figure 3: Monthly average maximum, minimum and mean temperatures (ºC) and monthly rainfall (mm) at Port Shepstone (top) and Paddock (bottom) (SAWS, 1998)

The wind over the coast and the adjacent interior of the Ray Nkonyeni Local Municipality is described by means of wind roses at Sezela and Paddock, respectively (Figure 4.2). Wind roses simultaneously depict the frequency of occurrence of hourly winds wind from the 16 cardinal wind directions and in different wind speed classes. Wind direction is given as the direction from which the wind blows, i.e., south-westerly winds blow from the south-west. Wind speed is given in m/s, and each arc in the wind rose represents a percentage frequency of occurrence (3% in this case).

The predominant winds are associated with the eastward ridging on the high pressure system, with coastal lows and with the passage of frontal systems. These synoptic scale winds are generally aligned with the coastline and at Sezela winds occur predominantly in the sector north to north-east (about 30%) and in the sector south-west to west south-west (about 20%). The strongest winds (> 8.5 m/s) are from the north-east. Light off-shore north to north-westerly land breezes occur in the winter, but there is no evidence of on-shore sea breezes. The dominant synoptic scale winds also occurs further inland at Paddock with nearly 30% of winds in the sectors north to east-northeast and south to south-west, respectively. As may be expected, a higher frequency of lighter winds is observed at Paddock than at Sezela.



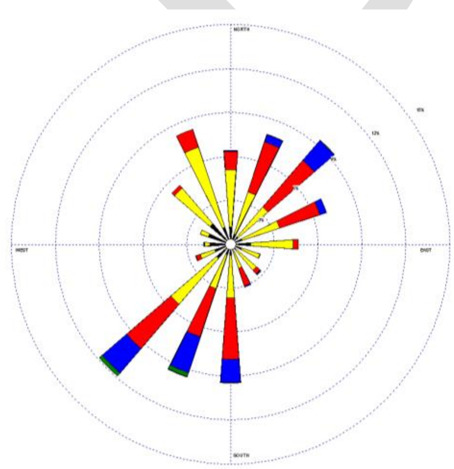


Figure 4: Annual wind roses at Sezela (left) and Paddock (right)

5.1.2 National Ambient Air Quality Standards and Guidelines

The effects of air pollutants on human health occur in a number of ways with short-term or acute effects, and chronic or long-term effects. Different groups of people are affected differently, depending on their level of sensitivity, with the elderly and young children being more susceptible. Factors that link the concentration of an air pollutant to an observed health effect are the concentration and the duration of the exposure to that particular air pollutant.

Criteria pollutants occur ubiquitously in urban and industrial environments. Their effects on human health and the environment are well documented by the World Health Organisation (WHO) (e.g. WHO, 1999; 2003; 2005). South Africa has accordingly established NAAQS for the criteria pollutants, i.e. SO_2, NO_2, CO, respirable particulate matter (PM_{10}), ozone (O_3), Pb and benzene (C_6H_6) (DEA, 2009) and $PM_{2.5}$ (DEA, 2012).

The NAAQS consists of a 'limit' value and a permitted frequency of exceedance. The limit value is the fixed concentration level aimed at reducing the harmful effects of a pollutant. The permitted frequency of exceedance represents the acceptable number of exceedances of the limit value expressed as the 99th percentile. Compliance with the ambient standard implies that the frequency of exceedance of the limit value does not exceed the permitted tolerance. Being a health-based standard, ambient concentrations below the standard imply that air quality poses an acceptable risk to human health, while exposure to ambient concentrations above the standard implies that there is an unacceptable risk to human health. The NAAQS for particulates (PM_{10} and $PM_{2.5}$), NO_2, SO_2 and CO are presented in Table 13.

Table 13: Ambient air quality standards

Pollutant	Averaging period	Limit value (µg/m^3)	Tolerance
PM_{10}	24 hour	75	4
	1 year	40	0
$PM_{2.5}$	24 hour	40	4
	1 year	20	0
NO_2	1 hour	200	88
	1 year	40	0
SO_2	1 hour	350	88
	24 hour	125	4
	1 year	50	0
CO	8-hour running mean	10 000	11

The sections below provide a literature review of particulates (PM_{10} and $PM_{2.5}$), NO_x, SO_2 and CO from an air quality and human health perspective.

Particulate Matter

Particulate Matter (PM) is a broad term used to describe the fine particles found in the atmosphere, including soil dust, dirt, soot, smoke, pollen, ash, aerosols and liquid droplets. With PM, it is not just the chemical composition that is important but also the particle size. Particle size has the greatest influence on the behaviour of PM in the atmosphere with smaller particles tending to have longer residence times than larger ones. PM is categorised, according to particle size, into TSP, PM_{10} and $PM_{2.5}$.

Total suspended particulates (TSP) consist of all particles smaller than 100 µm suspended within the air. TSP is useful for understanding nuisance effects of PM, e.g. settling on houses, deposition on and discolouration of buildings, and reduction in visibility.

PM_{10} describes all particulate matter in the atmosphere with a diameter equal to or less than 10 µm. Sometimes referred to simply as coarse particles, they are generally emitted from motor vehicles, factory and utility smokestacks, construction sites, tilled fields, unpaved roads, stone crushing, and burning of wood. Natural sources include sea spray, windblown dust and volcanoes. Coarse particles tend to have relatively short residence times as they settle out rapidly and PM_{10} is generally found relatively close to the source except in strong winds.

$PM_{2.5}$ describes all particulate matter in the atmosphere with a diameter equal to or less than 2.5 µm. They are often called fine particles, and are mostly related to combustion (motor vehicles, smelting, cremators), rather than mechanical processes as is the case with PM_{10}. $PM_{2.5}$ may be suspended in the atmosphere for long periods and can be transported over large distances. Fine particles can form in the atmosphere in three ways: when particles form from the gas phase, when gas molecules aggregate or cluster together without the aid of an existing surface to form a new particle, or from reactions of gases to form vapours that nucleate to form particles.

Particulate matter may contain both organic and inorganic pollutants. The extent to which particulates are considered harmful depends on their chemical composition and size, e.g. particulates emitted from diesel vehicle exhausts mainly contain unburned fuel oil and hydrocarbons that are known to be carcinogenic. Very fine particulates pose the greatest health risk as they can penetrate deep into the lung, as opposed to larger particles that may be filtered out through the airways' natural mechanisms.

In normal nasal breathing, particles larger than 10 µm are typically removed from the air stream as it passes through the nose and upper respiratory airways, and particles between 3 µm and 10 µm are deposited on the mucociliary escalator in the upper airways. Only particles in the range of 1 µm to 2 µm penetrate deeper where deposition in the alveoli of the lung can occur (WHO, 2003). Coarse particles (PM_{10} to $PM_{2.5}$) can accumulate in the respiratory system and aggravate health problems such as asthma. $PM_{2.5}$, which can penetrate deeply into the lungs, are more likely to contribute to the health effects (e.g. premature mortality and hospital admissions) than coarse particles (WHO, 2003).

The WHO has reviewed many studies since 2005 to update information on health effects on PM (WHO, 2013). Studies have once again confirmed that PM (not only PM_{10} but fine and ultra-fine PM as well), has short and long-term (both immediate and delayed) adverse health effects such as cardiovascular effects, but new associations with diseases such as atherosclerosis (thickening of artery walls), birth defects and respiratory illness in children have also been found (WHO, 2013). In addition, some studies have suggested a possible link between PM and diabetes and effects on the central nervous system (WHO, 2013). The increase in daily mortality (between 0.4% and 1%) from exposure to PM_{10} was also confirmed in several studies since 2005 (WHO, 2013).

Nitrogen dioxide (NO_2)

Nitrogen dioxide (NO_2) and nitric oxide (NO) are formed simultaneously in combustion processes and other high temperature operations such as metallurgical furnaces, blast furnaces, plasma furnaces, and kilns. NO_X is a term commonly used to refer to the combination of NO and NO_2. NO_X can also be released from nitric acid plants and other types of industrial processes involving the generation and/or use of nitric acid. NO_X also forms naturally through de-nitrification by anaerobic bacteria in soils and plants. Lightning is also a source of NO_X.

The route of exposure to NO_2 is inhalation and the seriousness of the effects depend more on the concentration than on the length of exposure. The site of deposition for NO_2 is the distal lung where NO_2 reacts with moisture in the fluids of the respiratory tract to form nitrous and nitric acids. About 80 to 90% of inhaled nitrogen dioxide is absorbed through the lungs (CCINFO, 1998). Nitrogen dioxide (present in the blood as the nitrite ion) oxidises unsaturated membrane lipids and proteins, which then results in the loss of control of cell permeability. Nitrogen dioxide causes decrements in lung function, particularly increased airway resistance. Inflammatory reactions were observed at NO_2 concentrations between 200 and 1000 ppb (380 to 1880 µg/m^3) when individuals were exposed under controlled conditions for periods that varied between 15 minutes and six hours (WHO, 2013). However, the results had been inconsistent below 1000 ppb but were much more evident at concentrations higher than 1000 ppb (1880 µg/m^3) (WHO, 2013). Below 1000 ppb healthy individuals did not show inflammatory reactions and for those with respiratory diseases (asthma and chronic obstructive pulmonary disease), inflammation was not induced below 600 ppb, except for one study that reported individuals responded at 260 ppb (500 µg/m^3) (Hesterberg et al., 2009). A review study (on 50 publications) published in 2009 by Hesterberg et al. focussed on short-term exposure to NO_2 and adverse health effects on humans. The authors came to the conclusion that a short-term exposure standard of not more than 200 ppb would protect all individuals, including sensitive individuals. People with chronic respiratory problems and people who work or exercise outside will be more at risk to NO_2 exposure.

Chronic exposure to NO_2 increases susceptibility to respiratory infections (WHO, 1997). However, a review study of 50 publications found no consistent evidence that short-term exposure below 200 ppb increased susceptibility to viral infections (Hesterberg et al., 2009). The WHO has reviewed hundreds of studies published between 2004 and 2011 on adverse health effects after short-term and long-term exposure to NO_2 (WHO, 2013). The health effects from short-term exposure are more evident than those from long-term (chronic) exposure, because in many studies a high correlation was found between NO_2 and other pollutants (WHO, 2013). However, some epidemiology studies suggested an association between NO_2 and respiratory mortality and an association with respiratory effects in children, including effects on children's lung function (WHO, 2013).

Sulphur dioxide (SO_2)

Dominant sources of SO_2 include fossil fuel combustion from industry and power plants. SO_2 is emitted when coal is burnt for energy. The combustion of fuel oil also results in high SO_2 emissions. Domestic coal or kerosene burning can thus also result in the release of SO_2. Motor vehicles also emit SO_2, in particular diesel vehicles due to the higher sulphur content of diesel fuel. Smelting of mineral ores can also result in the production of SO_2, because metals usually exist as sulphides within the ore.

On inhalation, most SO_2 only penetrates as far as the nose and throat, with minimal amounts reaching the lungs, unless the person is breathing heavily, breathing only through the mouth, or if the concentration of SO_2 is high (CCINFO, 1998). The acute response to SO_2 is rapid, within 10 minutes in people suffering from asthma (WHO, 2005). Effects such as a reduction in lung function, an increase in airway resistance, wheezing and shortness of breath, are enhanced by exercise that increases the volume of air inspired, as it allows SO_2 to penetrate further into the respiratory tract (WHO, 1999). SO_2 reacts with cell moisture in the respiratory system to form sulphuric acid. This can lead to impaired cell function and effects such as coughing, broncho-constriction, exacerbation of asthma and reduced lung function. For example an exposure of 5 to 10 min to 200 to 300 ppb (520 to 780 µg/m^3) may reduce lung function (measured as Forced Expiratory Volume in the first second

(FEV_1)) by more than 15% (USEPA, 2009). There is however, uncertainty about exposure-response effects below concentrations of 200 ppb (520 µg/m^3). For SO_2 exposure short-term peak concentrations are therefore important (USEPA, 2009). Re-analysis of the effects of SO_2 done post-2005 has found evidence to suggest that the point of departure for setting the 10-minute guideline needs an additional uncertainty factor, which indicates that the guideline may have to be lowered when it is re-evaluated (WHO, 2013).

Carbon monoxide

CO is an odourless, colourless and toxic gas. People with pre-existing heart and respiratory conditions, blood disorders and anaemia are sensitive to the effects of CO. Health effects of CO are mainly experienced in the neurological system and the cardiovascular system (WHO, 1999). The binding of CO with haemoglobin reduces the oxygen-carrying capacity of the blood and impairs the release of oxygen from haemoglobin to extravascular tissues. These are the main causes of tissue hypoxia produced by CO at low exposure levels. The toxic effects of CO become evident in organs and tissues with high oxygen consumption such as the brain, the heart, exercising skeletal muscle and the developing fetus.

5.1.3 Current Status of Ambient Air Quality

Ambient air quality monitoring in the Ugu District Municipality is carried out by various organisations, measuring a range of pollutants (Table 11) with the relative locations shown in Figure 16. An air quality screening study conducted in 2008 (uMoya-NILU, 2008a), provides relatively recent information on air quality in the region. The DAEA established an ambient monitoring station in Marburg that provides data for this industrialised area. NPC-Cimpor has been monitoring ambient air quality and dust fallout in the vicinity of the Simuma plant using real time monitors as well as sampling campaigns. Similarly, Idwala Carbonates conducts routine dust fallout monitoring and PM_{10} campaigns.

Table 11: Summary of ambient monitoring campaigns in the Ugu District Municipality

Organisation	Location	Parameters	Date
Ugu District Municipality	Park Rynie Marburg Sezela Sugar Mill	• SO_2 • NO_2 • H_2S • BTEX	2008
DAEA	Port Shepstone	• SO_2 • NO_x • O_3 • PM_{10}	2007
NPC Cimpor	Vicinity of the cement mill	• NO_2 • PM_{10} • SO_2	???
Idwala Cements	Vicinity of the mine	• PM_{10}	2010

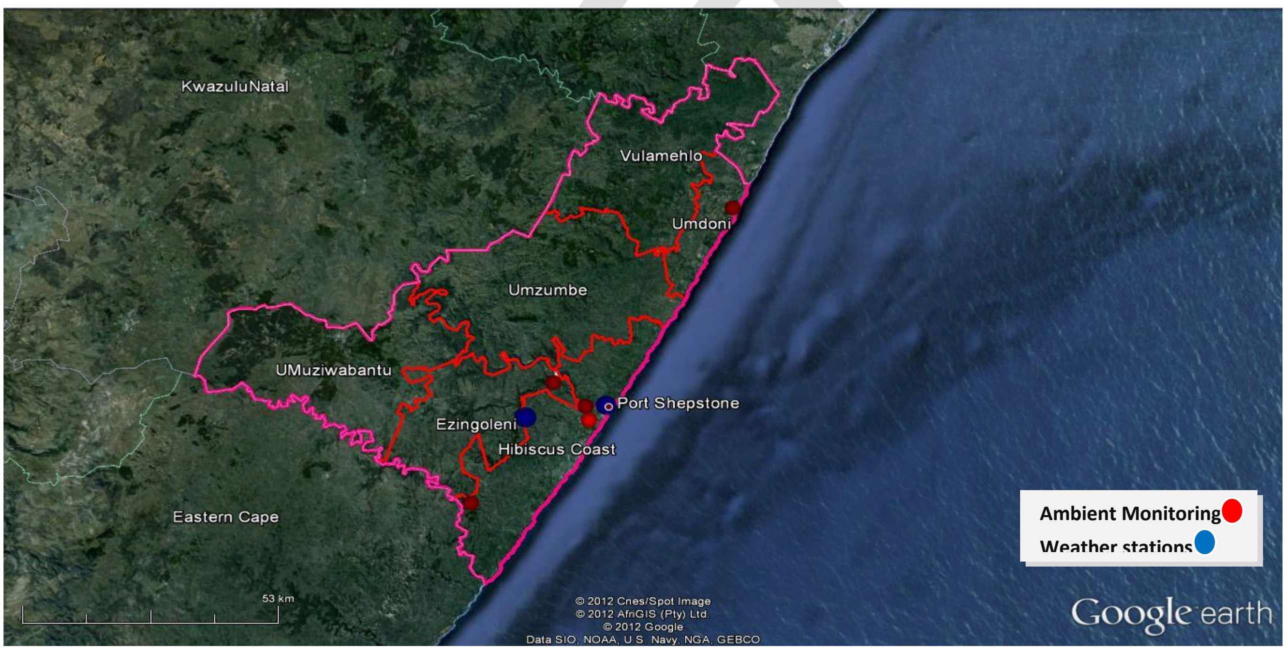


Figure 16: Ambient air quality monitoring activities in the Ugu District Municipality

The air quality impact assessment conducted for the Wild Coast N2 Toll Road (CSIR, 2008) assessed impacts on air quality of the current and projected traffic volumes with and without the toll road. In the Ray Nkonyeni Municipality, the study assessed points on the N2 at Scottburgh and Park Rynie up to 500 m from the roadside. As with all roadways, the highest concentrations of CO, NO_2 and PM_{10} were predicted to occur within 50 m of the roadway, decreasing rapidly with distance from the roadway. In the zone of maximum concentration, the predicted concentrations at both locations were consistently below the national ambient air quality standards for current and projected traffic volumes. The effects of traffic emissions from the N2 are localised and limited to the road reserves.

PM_{10} and O_3 concentrations from the DAEA monitoring station in Marburg are shown in Figure 17. For the year of 2007, daily average PM_{10} concentrations in Marburg were mostly below the ambient air quality standard with the exception of some exceedance events between January and April period. It is unclear from the data whether these are real concentration values of data spikes as a result of instrument errors, e.g. power surges.

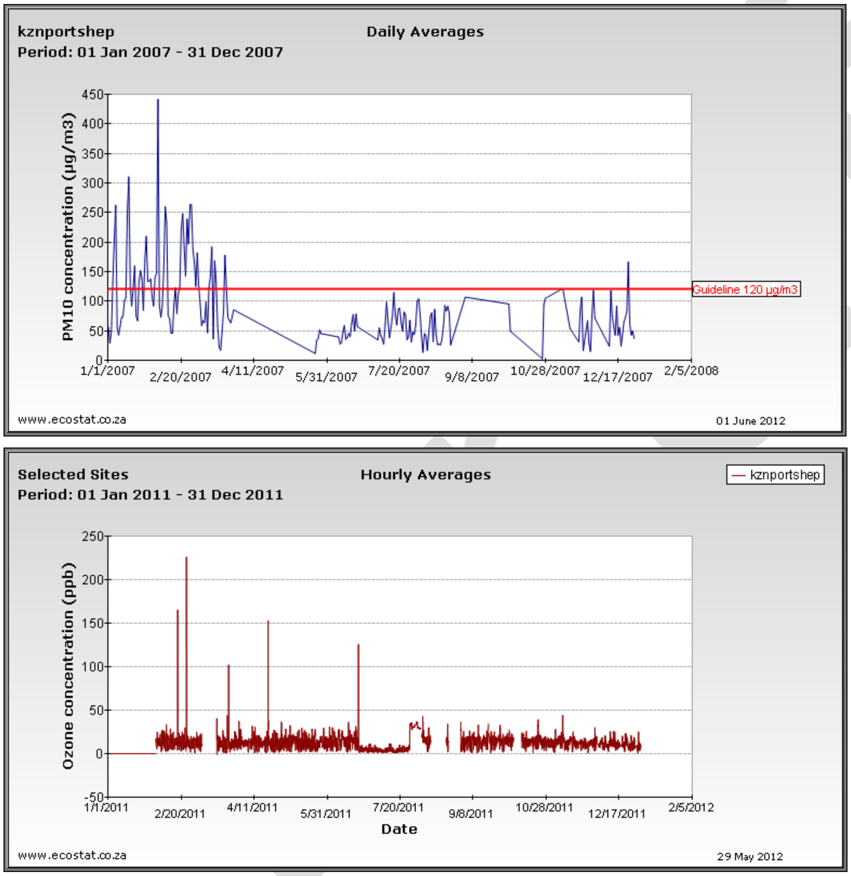


Figure 17: PM_{10} (top) and O_3 (bottom) concentrations at Marburg (DAEA, 2012)

Zanokuhle Environmental Services (ZES) conducted a short term air quality monitoring study for the Umuziwabantu Local Municipality in the town of Harding (Zanokuhle Environmental Services, 2011). NO_2, SO_2 & BTEX, CO, PM_{10} were the parameters measured at sampling sites in the Harding area.

The findings of this study indicated that ambient concentrations of all monitored pollutants were within South African Ambient Air Quality Standards apart from CO. Comparisons between pollutant concentrations observed in summer and winter were also made. O_3 and NO_2 concentrations were higher in Winter and BTEX and CO concentrations higher in Summer (Zanokuhle Environmental Services). Mapping pollutant distributions revealed that the CBD area experienced higher concentrations of pollutants with the exception of sulphur dioxide. Higher ambient SO_2 concentrations dominated the eastern and north-eastern half of the town (Zanokuhle Environmental Services, 2011).

Indoor air pollutant concentrations were measured in the Eastern areas of Harding (Zanokuhle Environmental Services, 2011). CO and VOC exceedances were recorded. However, due to the limited sample size, it is not possible to draw definitive conclusions on indoor air pollution in the Harding area, based on this data. The most likely contributing factors to concentrations of VOCs in the Harding area are indoor smoking, use of paraffin and other chemicals and to a lesser extent vehicles idling (Zanokuhle Environmental Services, 2011).

Air quality specialist studies and ambient monitoring at both Simuma (CSIR, 2006; uMoya-NILU, 2011 and 2012) and Idwala Carbonates (uMoya-NILU, 2010 and 2012) have shown that the air quality impacts from these activities are relatively localised. At Simuma, the results of the ambient concentrations of SO_2 and NO_2 are relatively low at the monitoring area in winter and summer and neither pollutant exceeded the health-based standards (uMoya-NILU, 2010). Daily average PM_{10} concentrations are relatively high, adjacent to the plant and at the Oribi Hotel. Both monitoring sites have higher concentrations in winter than in summer when exceedances of national ambient standards occurred. At Idwala during winter and summer monitoring campaigns (uMoya-NILU, 2011) the current 24-hour South African ambient standard of 120 $\mu g/m^3$ was not exceeded in the vicinity of this operation. The 24-hour ambient standard for 2015 of 75 $\mu g/m^3$ was also not exceeded.

Based on existing ambient monitoring data, meteorological information and an understanding of the emission sources the air quality in the Ugu District Municipality may be described as generally good, with the exception of areas around localised sources. These localised sources include areas of industrial activity, along the N2 at times of high traffic volumes, residential areas where wood is used for cooking and heating, and areas temporarily affected by sugar cane burning.

5.1.4 Dispersion Modelling

Dispersion modelling is used to predict ambient concentrations of particulates (PM_{10} and $PM_{2.5}$), NO_2, SO_2 and CO resulting from emissions from the proposed new cremator at the

Izotsha Crematorium. The approach to the dispersion modelling in this assessment is based on the requirements of the DEA guideline for dispersion modelling (DEA, 2014).

According to the DEA guideline for dispersion modelling, a Level 1 air quality assessment is conducted in situations where the purpose of the assessment is to provide an estimate of the worst-case air quality impacts. As such, screening models are sufficient for this level. In the case of this study, a Level 1 assessment is appropriate since the focus of the study is on a licence approval decision; and it deals with the preliminary identification of air quality issues associated with proposed new sources or modifications to existing sources. The DEA recommend the USEPA approved SCREEN3 model for Level 1 assessments (DEA, 2014).

Operating Scenario for Dispersion Modelling

The proposed new cremator at the Izotsha Crematorium is modelled for the maximum design capacity, that is, 11 bodies cremated per day.

Dispersion Modelling Procedures

SCREEN3 is the USEPA's current regulatory screening model for many air permitting applications. It is the recommended tool to calculate screening-level impact estimates for stationary sources. The model is based on steady-state Gaussian plume algorithms and is applicable for estimating ambient impacts from point, area, and volume sources out to a distance of about 50 km. In addition, SCREEN3 can be used to model flares. SCREEN3 also includes algorithms for addressing building downwash influences, including the cavity recirculation region, and incorporates the valley 24-hour screening algorithm for estimating complex terrain impacts. The SCREEN3 model uses a matrix of meteorological conditions covering a range of wind speed and stability categories. The model is designed to estimate the worst-case impact based on the meteorological matrix for use as a conservative screening technique. The SCREEN3 model does not use hourly meteorological data. Instead, the user can select one of the following options:

- Full Meteorology – model uses a predefined matrix of meteorological conditions that references all stability classes (A through F) and associated wind speeds, where the maximum wind speed is stability-dependent;
- Single Stability Class – user selects a single stability category, and the model automatically examines all wind speeds appropriate for that category; or
- Single Stability Class and Wind Speed – user selects a single stability category and wind speed combination.

The Full Meteorology option is used for routine application of the SCREEN3 model.

SCREEN3 is a single source model. Nevertheless, the impacts from multiple SCREEN3 model runs can be summed to conservatively estimate the impact from several sources. The SCREEN3 Model User's Guide (USEPA, 1995) can be consulted for more technical information on the model. SCREEN3 does not take wind direction and topography into account. The model calculates maximum concentrations at specified distances, but these may occur in any direction from the source. The prevailing wind directions are used to obtain an indication of the general direction in which the pollution plume would travel.

Dispersion Modelling Domain and Grid Receptors

In SCREEN3, the model domain is defined on the basis of the distance from the sources of concern to the receptors of interest. In this study a modelling domain of 25 km^2 which is 5 km (west-east) by 5 km (north-south), centred on the proposed new cremator at the Izotsha Crematorium is used for the model runs. Receptor points are spaced 100 m apart from the source to 3 km away, and then every 500 m apart between 3 km and 5 km away from the source.

Model Parameterisation

The parameterisation of key variables used in SCREEN3 are listed in Table 14.

Table 14: Parameterisation of key variables for SCREEN3

Parameter	Model value
Source type	point
Stack height (m)	11.4
Stack inside diameter (m)	0.6
Stack exit velocity (m/s)	2.5
Stack gas exit temp (K)	450
Ambient air temp (k)	293
Receptor height (m)	0
Automated distances (m)	1 – 5 000
Buoyancy flux (m^4/s^3)	0.938
Momentum flux m^4/s^2)	0.227
Anemometer height (m)	10
Mixing height option	Regulatory
Urban/rural option	Rural
Meteorology	Full meteorology
Terrain	Simple terrain

Model Accuracy

Air quality models attempt to predict ambient concentrations based on "known" or measured parameters, such as wind speed, temperature profiles, solar radiation and emissions. There are however, variations in the parameters that are not measured, the so-called "unknown" parameters as well as unresolved details of atmospheric turbulent flow. Variations in these "unknown" parameters can result in deviations of the predicted concentrations of the same event, even though the "known" parameters are fixed.

There are also "reducible" uncertainties that result from inaccuracies in the model, errors in input values and errors in the measured concentrations. These might include poor quality or unrepresentative meteorological, geophysical and source emission data, errors in the measured concentrations that are used to compare with model predictions and inadequate model physics and formulation used to predict the concentrations. "Reducible" uncertainties can be controlled or minimised. This is achieved by making use of the most appropriate input data, preparing the input files correctly, checking and re-checking for errors, correcting for odd model behaviour, ensuring that the errors in the measured data are minimised and applying appropriate model physics.

Models recommended in the DEA dispersion modelling guideline (DEA, 2014) have been evaluated using a range of modelling test kits (http://www.epa.gov./scram001). It is therefore not mandatory to perform any modelling evaluations. Rather the accuracy of the modelling in this assessment is enhanced by every effort to minimise the "reducible" uncertainties in input data and model parameterisation.

For the proposed new cremator at the Izotsha Crematorium the reducible uncertainty in SCREEN3 is minimised by:

- Applying appropriate parameterisation of the model;
- Using representative emission data; and
- Using a competent modelling team with considerable experience using SCREEN3.

The limitations of SCREEN3 being a one dimensional model need to be borne in mind when evaluating the model outputs.

Background Concentrations and Other Sources

A background concentration is the portion of the ambient concentration of a pollutant due to sources, both natural and anthropogenic, other than the source being assessed. Other sources of particulates (PM_{10} and $PM_{2.5}$), NO_2, SO_2 and CO will not be characterised and included in the model run. The proposed new cremator at the Izotsha Crematorium is modelled in isolation of other sources.

Sensitive Receptors

According to the USEPA, sensitive receptors include, but are not limited to, hospitals, schools, day care facilities, elderly housing and convalescent facilities. These are areas where the occupants are more susceptible to the adverse effects of exposure to toxic chemicals, pesticides, and other pollutants. Extra care must be taken when dealing with contaminants and pollutants in close proximity to areas recognised as sensitive receptors.

In this assessment, all neighbouring residential and commercial areas (Figure 1) are treated as sensitive areas as they are expected to include sensitive areas as identified by the USEPA. The sensitive receptors in the vicinity of the Izotsha Crematorium are listed in Table 15, in terms of distance and direction from the crematorium.

Table 15: Sensitive receptors in the vicinity of the Izotsha Crematorium located in Ray Nkonyeni

Sensitive Receptor	Distance from Crematorium (km)	Direction from Crematorium
Farmhouse	0.65	East
Shelley Beach Shopping Centre	0.75	South-east
Shelley Beach	0.77	East and sout-east
St. Michaels-On-Sea	3.5	South-east

Dispersion Modelling Results

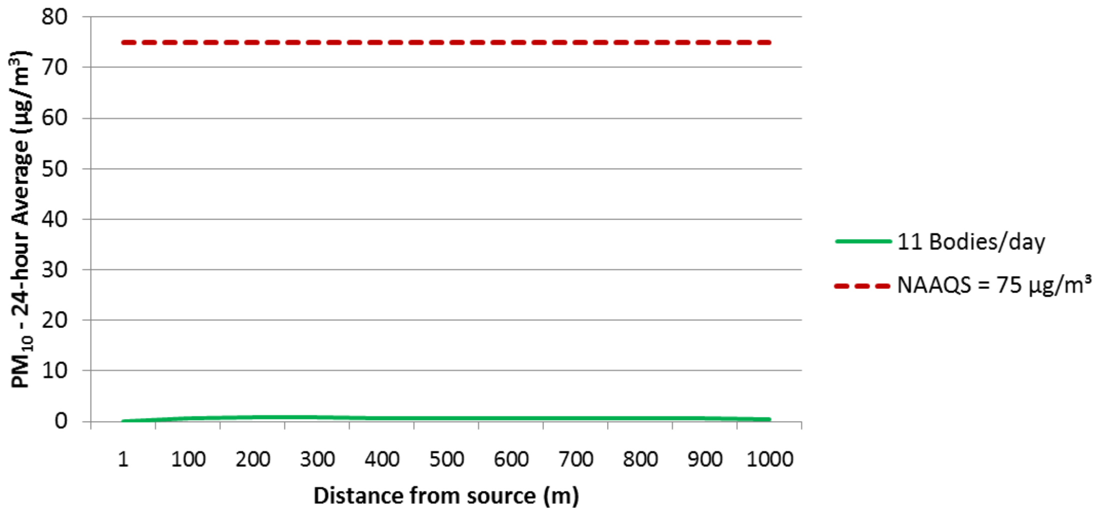
The dispersion modelling results for the predicted 1-hour, 8-hour, 24-hour and annual average ambient concentrations of particulates (PM_{10} and $PM_{2.5}$), NO_2, SO_2 and CO resulting from emissions from the proposed new cremator are presented in Figure 5 to Figure 9. The predicted ambient concentrations are based on uncontrolled emissions and are assessed against the respective National Ambient Air Quality Standards. The highest predicted ambient concentrations from the dispersion modelling exercise is presented in Table 16.

Table 16: Maximum predicted ambient concentrations for the proposed new cremator

Pollutant	**Ambient Concentration (µg/m³)**		
	1-hour	**24-hour**	**Annual Average**
PM_{10}	-	0.77	0.15
$PM_{2.5}$	-	0.77	0.15
NO_2	46.04	-	3.68
SO_2	6.31	2.52	0.50
CO	-	5.47	0.62
Pb	-	-	0.134

Particulate Matter - PM_{10}

The predicted 24-hour average and annual average PM_{10} ambient concentrations resulting from emissions from the cremator for the cremation of 11 bodies/day are presented in Figure 5. The predicted 24-hour average and annual average PM_{10} concentrations are very low and well below the NAAQS of 75 µg/m^3 and 40 µg/m^3 respectively. The predicted ambient concentrations are very low on site and reach a maximum approximately 250 m downwind of the site. The highest predicted ambient concentrations are presented in Table 16. No exceedance of the NAAQS is predicted within the site or in residential and sensitive receptor areas around the site. The predicted PM_{10} concentrations therefore comply with the NAAQS in the ambient environment.



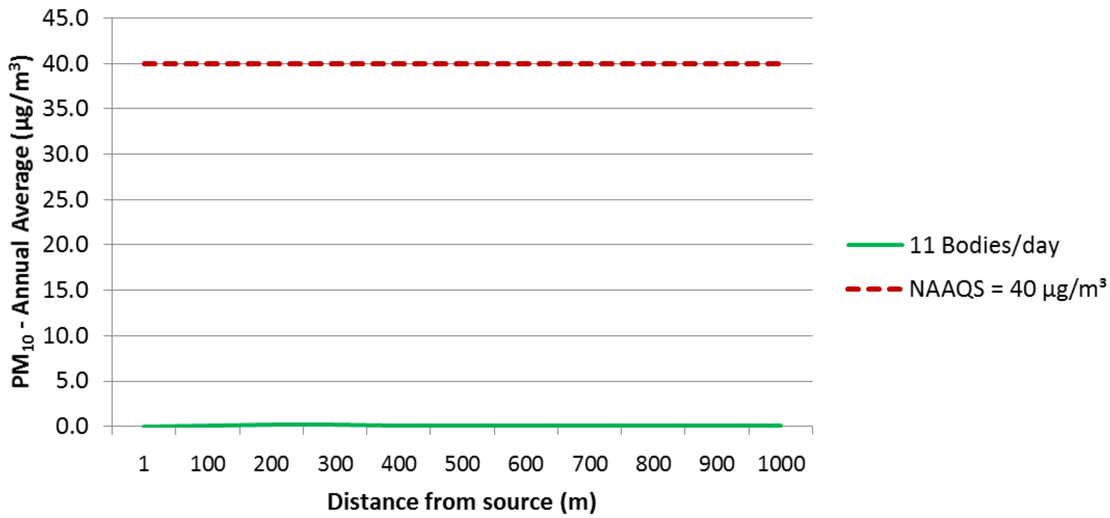
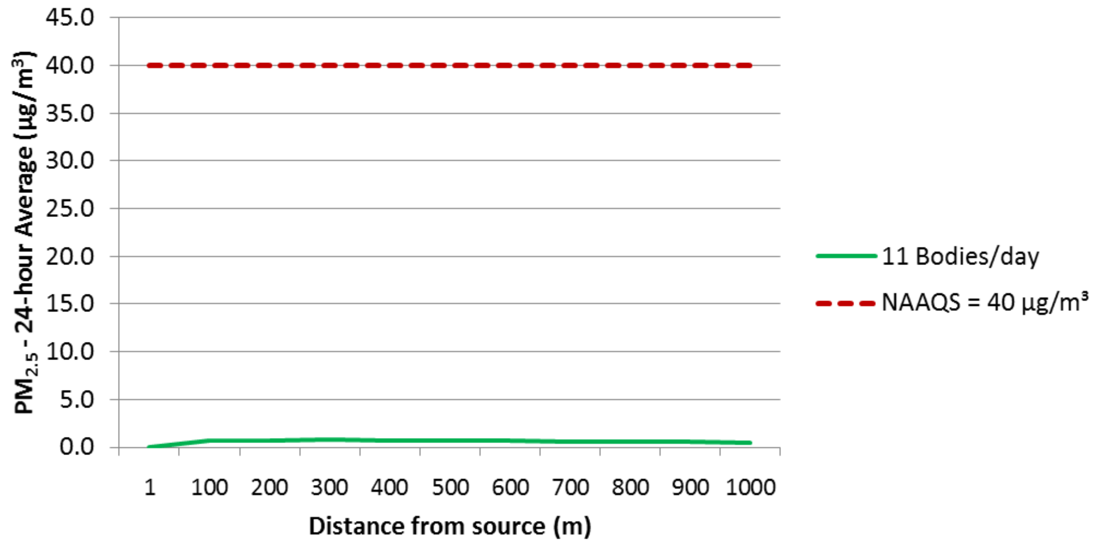


Figure 5: Predicted 24-hour average (top) and annual average (bottom) PM_{10} ambient concentrations in µg/m³ resulting from emissions from the cremator in isolation

Particulate Matter - $PM_{2.5}$

The predicted 24-hour average and annual average $PM_{2.5}$ ambient concentrations resulting from emissions from the cremator for the cremation of 11 bodies/day are presented in Figure 6. The predicted 24-hour average and annual average $PM_{2.5}$ concentrations are very low and well below the NAAQS of 40 µg/m³ and 20 µg/m³ respectively. The ambient concentrations are very low on site and reach a maximum approximately 250 m downwind of the site. The highest predicted ambient concentrations are presented in Table 16. No exceedance of the NAAQS is predicted within the site or in residential and sensitive receptor areas around the site. The predicted $PM_{2.5}$ concentrations therefore comply with the NAAQS in the ambient environment.



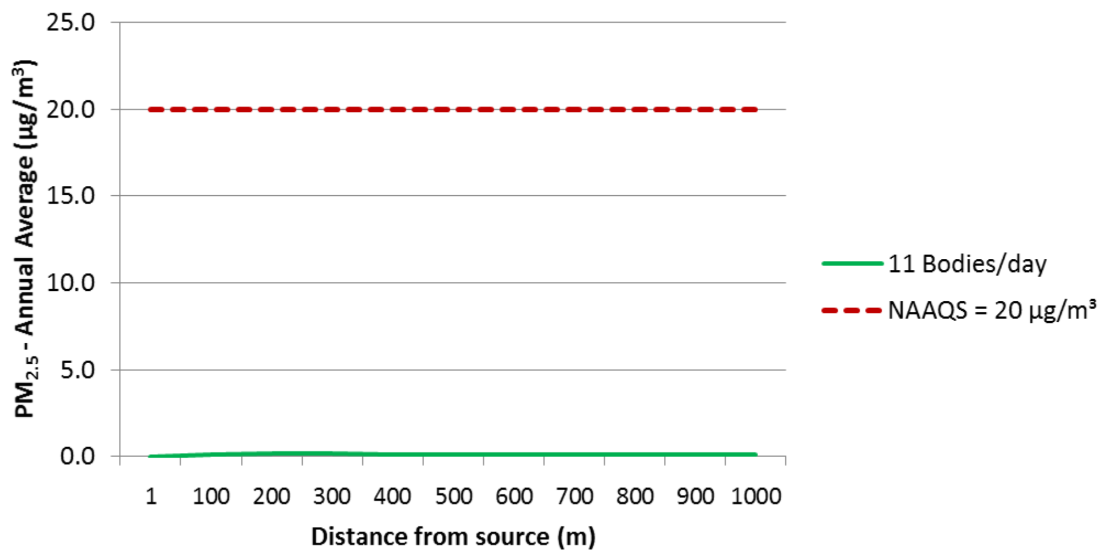


Figure 6: Predicted 24-hour average (top) and annual average (bottom) $PM_{2.5}$ ambient concentrations in µg/m³ resulting from emissions from the cremator in isolation

Oxides of Nitrogen (NO_x)

For the purpose of this assessment, the modelled NO_x concentrations (NO and NO_2) were assumed to be equal to NO_2 as NO is rapidly converted to NO_2 in the atmosphere.

The predicted 1-hour average and annual average NO_2 ambient concentrations resulting from emissions from the cremation of 11 bodies/day are presented in Figure 7. The predicted 1-hour average and annual average NO_2 concentrations are very low and well below the NAAQS of 200 µg/m^3 and 40 µg/m^3, respectively. The ambient concentrations are very low on site and reach a maximum approximately 350 m downwind of the site. The highest predicted ambient concentrations are presented in Table 16. No exceedance of the NAAQS is predicted within the site or in residential and sensitive receptor areas around the site. The predicted NO_2 concentrations therefore comply with the NAAQS in the ambient environment.

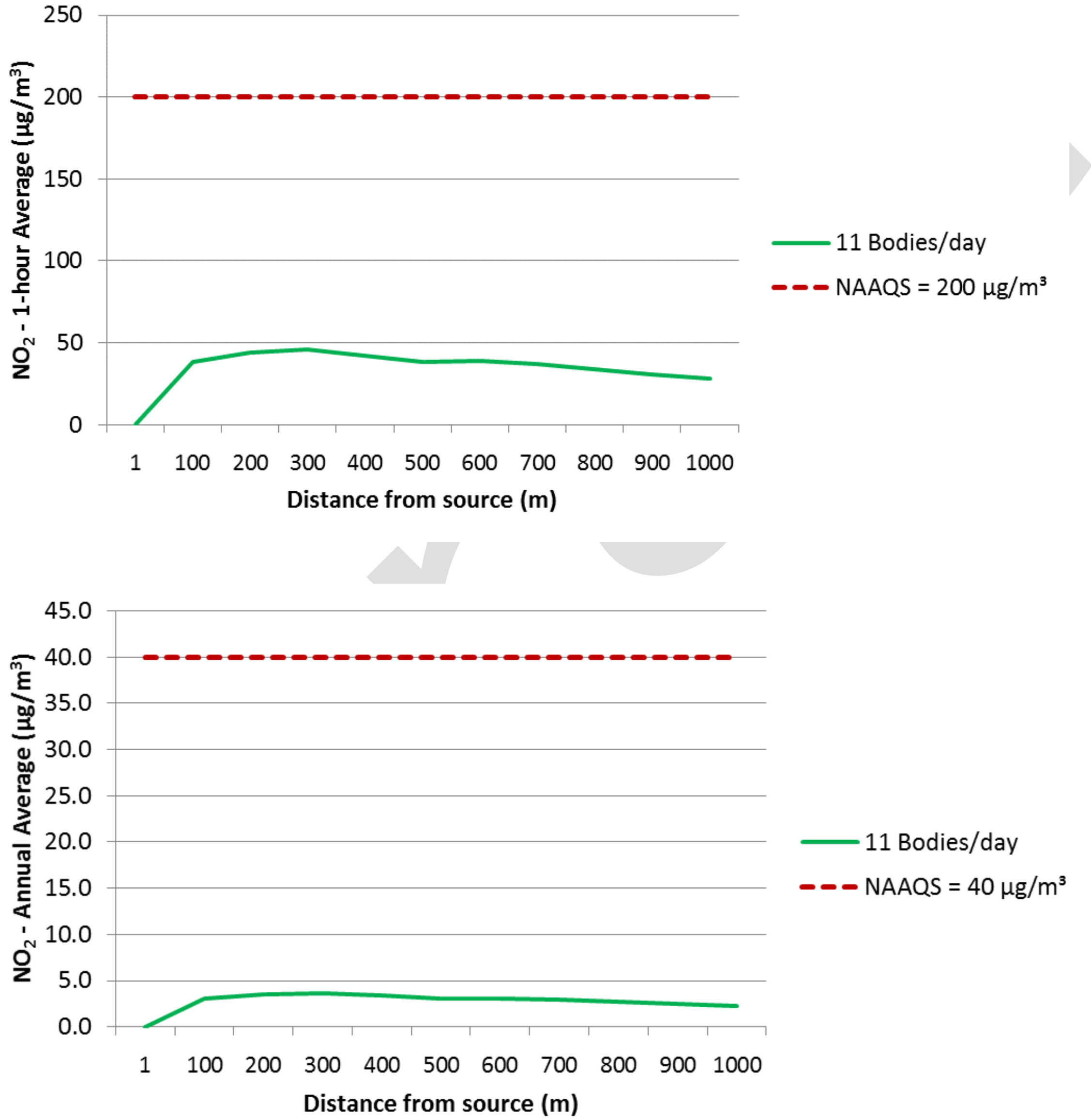
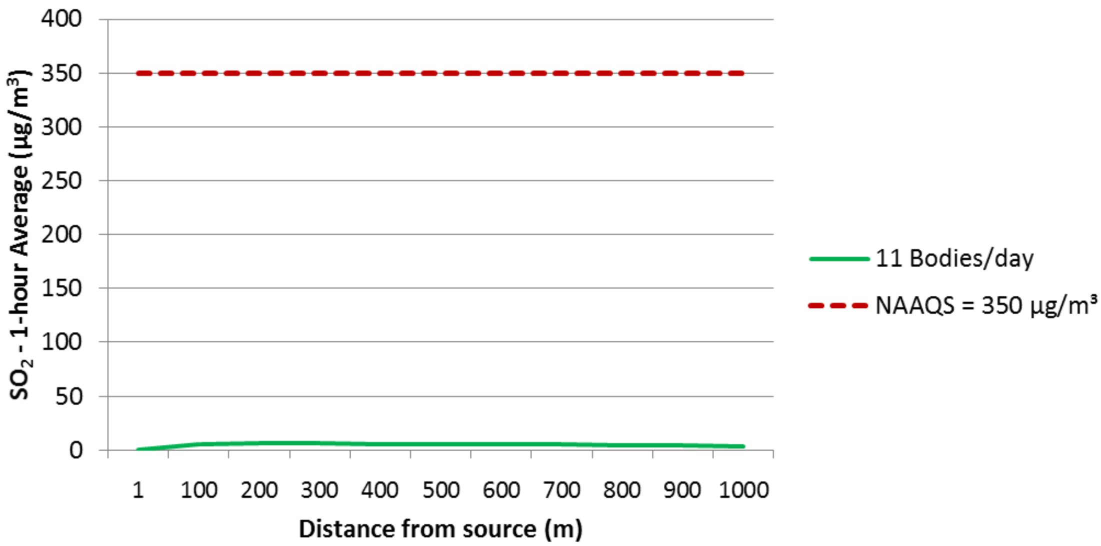
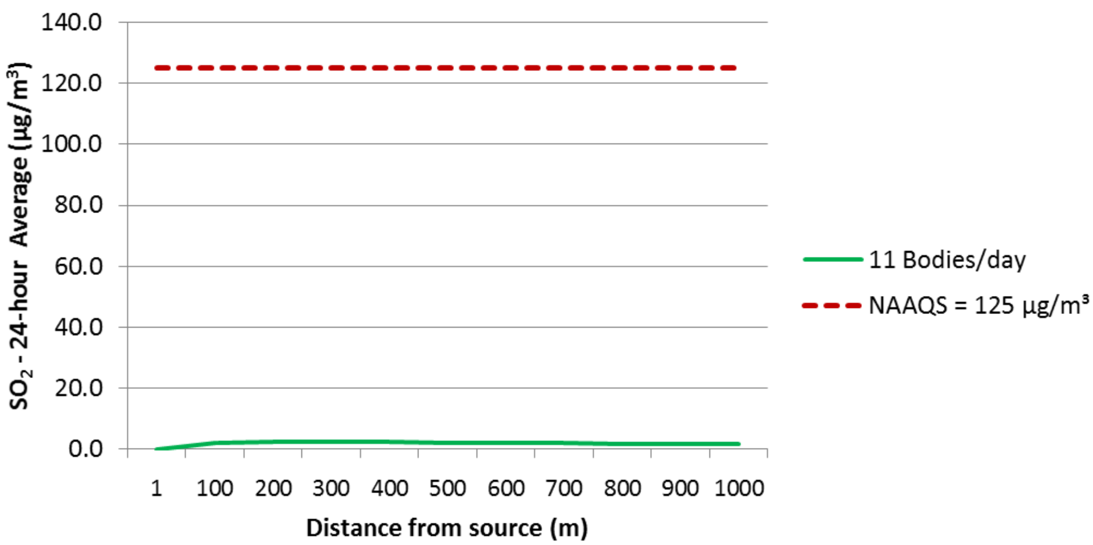


Figure 7: Predicted 1-hour average (top) and annual average (bottom) NO_2 ambient concentrations in µg/m^3 resulting from emissions from the cremator in isolation

Sulphur Dioxide (SO_2)

The predicted 1-hour average, 24-hour average and annual average SO_2 ambient concentrations resulting from emissions from the cremation of 11 bodies/day are presented in Figure 8. The predicted 1-hour, 24-hour and annual average SO_2 concentrations are very low and well below the NAAQS of 350 µg/m³, 125 µg/m³ and 50 µg/m³, respectively. The ambient concentrations are very low on site and reach a maximum approximately 375 m downwind of the site. The highest predicted ambient concentrations are presented in Table 16. No exceedance of the NAAQS is predicted within the site or in residential and sensitive receptor areas around the site. The predicted SO_2 concentrations therefore comply with the NAAQS in the ambient environment.





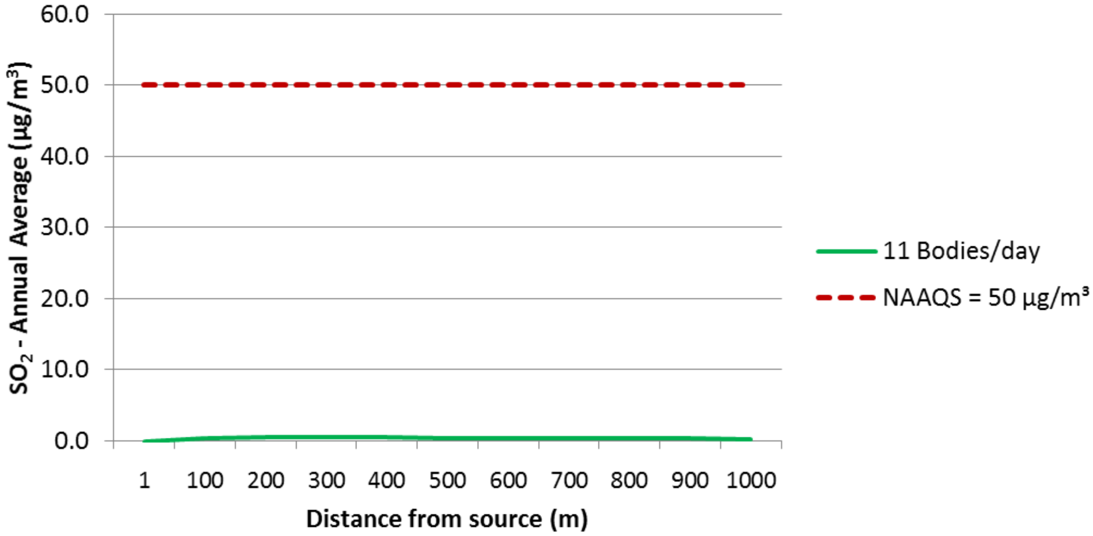


Figure 8: Predicted 1-hour average (top), 24-hour average (middle) and annual average (bottom) SO_2 ambient concentrations in µg/m^3 resulting from emissions from the cremator in isolation

Carbon Monoxide (CO)

The predicted 8-hour average CO ambient concentrations resulting from emissions from the cremation of 11 bodies/day are presented in Figure 9. The predicted 8-hour average CO concentrations are very low and well below the NAAQS of 10 000 µg/m^3. The ambient concentrations are very low on site and reach a maximum approximately 300 m downwind of the site. The highest predicted ambient concentrations are presented in Table 16. No exceedance of the NAAQS is predicted within the site or in residential and sensitive receptor areas around the site. The predicted CO concentrations therefore comply with the NAAQS in the ambient environment.

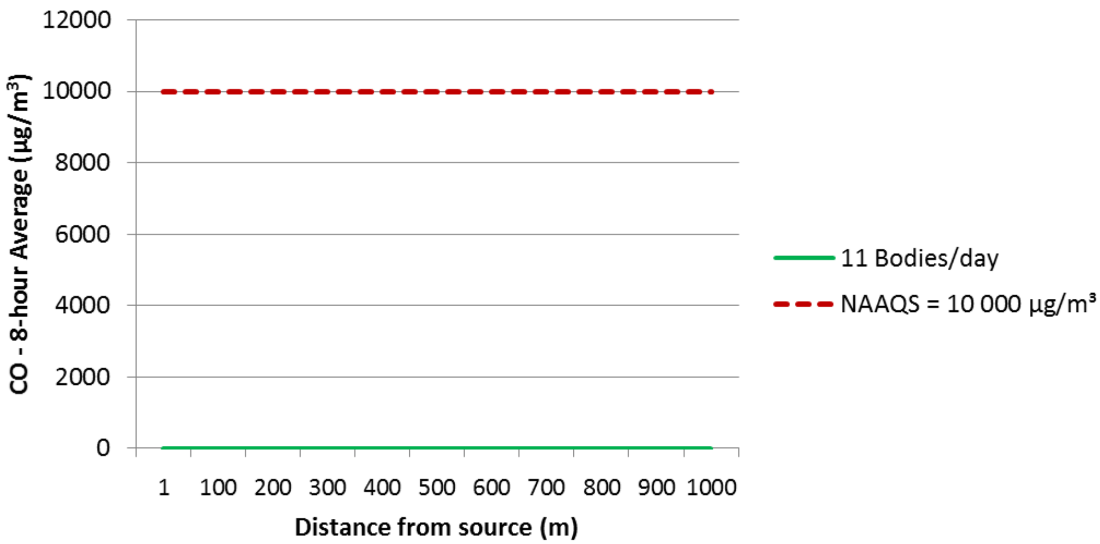


Figure 9: Predicted 8-hour average CO ambient concentrations in µg/m³ resulting from emissions from the cremator in isolation

Construction and Decommissioning

Prior to construction of the proposed new cremator at the Izotsha Crematorium, the ground will need to be prepared by undertaking the necessary excavations. The proposed new cremator and associated structures will be brought to site by truck and assembled at the location. Dust emissions and other emissions are not expected to be high during this process as the site is not located in a dusty environment. No additional construction or clearing of vegetation is foreseen and the site would remain in its current condition. No mitigation measures are therefore proposed.

During decommissioning of the cremator, the cremator structures will be disassembled and moved off site. Dust emissions and other emissions are not expected to be high during this process and the site would remain in its current condition. No mitigation measures are therefore proposed.

Impact Assessment

The potential impact of emissions of particulates (PM_{10} and $PM_{2.5}$), NO_x, SO_2 and CO resulting from emissions from the proposed new cremator is assessed according to the Impact Rating Procedure. The following criteria are applied:

Impact Rating Procedure

The significance of an impact is defined as a combination of the consequence of the impact occurring and the probability that the impact will occur. The criteria used to determine impact consequences are presented in Table 17.

Table 17: Criteria used to determine the Consequence of the Impact

Rating	Definition of Rating	Score
A. Extent– the area over which the impact will be experienced		
None		0
Local	Confined to project or study area or part thereof (e.g. site)	1
Regional	The region, which may be defined in various ways, e.g. cadastral, catchment, topographic	2
(Inter) national	Nationally or beyond	3
B. Intensity– the magnitude of the impact in relation to the sensitivity of the receiving environment		
None		0
Low	Site-specific and wider natural and/or social functions and processes are negligibly altered	1
Medium	Site-specific and wider natural and/or social functions and processes continue albeit in a modified way	2
High	Site-specific and wider natural and/or social functions or processes are severely altered	3
C. Duration– the time frame for which the impact will be experienced		
None		0
Short-term	Up to 2 years	1
Medium-term	2 to 15 years	2
Long-term	More than 15 years	3

The combined score of these three criteria corresponds to a Consequence Rating (Table 18).

Table 18: Method used to determine the Consequence Score

Combined Score (A+B+C)	0 – 2	3 – 4	5	6	7	8 – 9
Consequence Rating	Not significant	Very low	Low	Medium	High	Very high

Once the consequence has been derived, the probability of the impact occurring will be considered using the probability classifications presented in Table 19.

Table 19: Probability Classification

Probability– the likelihood of the impact occurring	
Improbable	< 40% chance of occurring
Possible	40% - 70% chance of occurring
Probable	> 70% - 90% chance of occurring
Definite	> 90% chance of occurring

The overall significance of impacts will be determined by considering consequence and probability using the rating system prescribed in the Table 20.

Table 20: Impact Significance Ratings

Significance Rating	Possible Impact Combinations		
	Consequence		Probability
Insignificant	Very Low	&	Improbable
	Very Low	&	Possible
Very Low	Very Low	&	Probable
	Very Low	&	Definite
	Low	&	Improbable
	Low	&	Possible
Low	Low	&	Probable
	Low	&	Definite
	Medium	&	Improbable
	Medium	&	Possible
Medium	Medium	&	Probable
	Medium	&	Definite
	High	&	Improbable
	High	&	Possible
High	High	&	Probable
	High	&	Definite
	Very High	&	Improbable
	Very High	&	Possible
Very High	Very High	&	Probable
	Very High	&	Definite

Finally, the impacts will also be considered in terms of their status (positive or negative impact) and the confidence in the ascribed impact significance rating. The system for considering impact status and confidence (in assessment) is laid out in Table 21.

Table 21: Impact status and confidence classification

Status of impact	
Indication whether the impact is adverse (negative) or beneficial (positive).	+ ve (positive – a 'benefit')
	– ve (negative – a 'cost')
Confidence of assessment	
The degree of confidence in predictions based on available information, SRK's judgment and/or specialist knowledge.	Low
	Medium
	High

The impact significance rating should be considered by authorities in their decision-making process based on the implications of ratings ascribed below:

- **Insignificant:** the potential impact is negligible and will not have an influence on the decision regarding the proposed activity/development.
- **Very Low:** the potential impact is very small and should not have any meaningful influence on the decision regarding the proposed activity/development.
- **Low:** the potential impact may not have any meaningful influence on the decision regarding the proposed activity/development.
- **Medium:** the potential impact should influence the decision regarding the proposed activity/development.
- **High:** the potential impact will affect the decision regarding the proposed activity/development.
- **Very High:** The proposed activity should only be approved under special circumstances.

Practicable mitigation measures will be recommended and impacts will be rated in the prescribed way both with and without the assumed effective implementation of mitigation measures. Mitigation measures will be classified as either:

- **Essential:** must be implemented and are non-negotiable; or
- **Optional:** must be shown to have been considered and sound reasons provided by the proponent, if not implemented.

"No-Go" alternative

In the case of the "No-Go" alternative, the cremator will not be installed and the facility will continue to comply with the relevant air quality standards and the site would remain in its current condition until/unless any other development is approved.

In most cases, the "No-Go" alternative approximates the baseline situation. In the sections assessing specific impacts below, the "No-Go" alternative is only assessed where the baseline descriptions do not fully capture current impacts.

Summary of Impacts

The potential impact of emissions of particulates (PM_{10} and $PM_{2.5}$), NO_x, SO_2 and CO resulting from emissions from the proposed new cremator is summarised in Table 22.

Impacts during construction and decommissioning with or without mitigation will be local in extent, low intensity, of a short-term duration and therefore of very low consequence. The probability of impacts occurring is improbable. The significance rating is therefore insignificant, implying that the potential impact is negligible and should not have a negative influence on the decision regarding the proposed development. The construction and decommissioning phase, with or without mitigation, will not have a significant negative impact on the environment. There is a high confidence associated with the impacts and the reversibility of the impacts is high.

Impacts during operation with or without mitigation will be local in extent, low intensity, of a long-term duration and therefore of low consequence. The probability of impacts occurring is improbable. The significance rating is therefore very low, implying that the potential impact is very small and should not have a negative influence on the decision regarding the proposed development. The operational phase, with or without mitigation, will not have a significant negative impact on the environment. There is a high confidence associated with the impacts and the reversibility of the impacts is high.

From an air quality perspective, it is therefore recommended that the project should go ahead.

Table 22: Impact Assessment for the construction, operational and decommissioning phase of the proposed new cremator

	Impact	Mitigation	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence	Reversibility
Construction	Impacts on Air Quality	Without	Local	Low	Short-term	Very low	Improbable	Insignificant	- ve	High	High
		With	Local	Low	Short-term	Very low	Improbable	Insignificant	- ve	High	
Operation	Impacts on Air Quality	Without	Local	Low	Long - term	Low	Improbable	Very Low	- ve	High	High
		With	Local	Low	Long-term	Low	Improbable	Very Low	- ve	High	
Decom-missioning	Impacts on Air Quality	Without	Local	Low	Short-term	Very low	Improbable	Insignificant	- ve	High	High
		With	Local	Low	Short-term	Very low	Improbable	Insignificant	- ve	High	

5.2 Analysis of Emissions' Impact on the Environment

An assessment of the atmospheric impact of the facility on the environment was not undertaken as part of this Atmospheric Impact Report.

6. COMPLAINTS

The Izotsha Crematorium has not received complaints in respect of air pollution as it is a new development and is not yet in operation.

7. CURRENT OR PLANNED AIR QUALITY MANAGEMENT INTERVENTIONS

The Izotsha Crematorium does not have any approved air quality management improvement interventions scheduled for the next 5 years.

8. COMPLIANCE AND ENFORCEMENT ACTIONS

The Izotsha Crematorium does not have any air quality compliance and enforcement actions undertaken against the enterprise.

9. SUMMARY AND CONCLUSION

European Environmental Agency emission factors are used to estimate emissions of particulates (PM_{10} and $PM_{2.5}$), oxides of nitrogen (NO_x), sulphur dioxide (SO_2) and carbon monoxide (CO) from the proposed new cremator at the Izotsha Crematorium, for the cremation of 11 bodies/day, under maximum design conditions. It is evident that resultant emission rates are relatively low, even with no emission control devices in place.

The DEA recommended and USEPA-approved SCREEN3 dispersion model is used to assess the effects and potential consequences of uncontrolled emissions from the proposed new cremator in the surrounding environment. Modelled ambient concentrations of PM_{10}, $PM_{2.5}$, NO_2, SO_2 and CO are considerably less than the respective health-based ambient air quality standards and the highest concentrations are predicted 250 m to 350 m from the cremator. No exceedance of the NAAQS is therefore predicted within the site or in residential and sensitive receptor areas around the site.

The significance rating for impacts during construction and decommissioning (with or without mitigation) is insignificant, implying that the potential impact is negligible and should not have a negative influence on the decision regarding the proposed development. The significance rating for impacts during operations (with or without mitigation) is very low, implying that the potential impact is very small and should not have a negative influence on the decision regarding the proposed development. From an air quality perspective, it is therefore recommended that the project should go ahead.

10. REFERENCES

CCINFO (1998): The Canadian Centre for Occupational Health and Safety database. http://ccinfoweb.ccohs.ca visited on 21 July 2003.

DEA (2009): National Ambient Air Quality Standards, Government Gazette, 32861, Vol. 1210, 24 December 2009.

DEA (2010): Listed Activities and Associated Minimum Emission Standards identified in terms of Section 21 of the Air Quality Act, Act No. 39 of 2004, Government Gazette 33064, Notice No. 248 of 31 March 2010.

DEA (2012): National Ambient Air Quality Standard for Particulate Matter of Aerodynamic Diameter less than 2.5 micrometers, Notice 486, 29 June 2012, Government Gazette, 35463.

DEA (2013): Listed activities and associated Minimum Emission Standards identified in terms of Section 21 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), Government Gazette Notice No. 893 of 22 November 2013.

DEA (2014): Code of Practice for Air Dispersion Modelling in Air Quality Management in South Africa, Government Notice R.533, Government Gazette, no. 37804, 11 July 2014.

DEA (2018): Amenments to the Listed Activities and Associated Minimum Emission Standards identified in terms of Section 21 of the National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004), Government Gazette Notice No. 1207 of 31 October 2018.

Hesterberg TW, Bunn WB, McClellan RO, Hamade AK, Long CM and Valberg PA. (2009): Critical Review of the Human Data on Short-term Nitrogen Dioxide (NO_2) Exposures: Evidence for NO_2 No-Effect Levels. Critical Reviews in Toxicology, 39(9): 743-81.

South African Weather Service (1998): Climate of South Africa, Climate Statistics up to 1984.

United States Environmental Protection Agency (USEPA) (1995): SCREEN3 Model User's Guide. EPA-454/B-95-004. U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards Emissions, Monitoring, and Analysis Division, Research Triangle Park, North Carolina.

United States Environmental Protection Agency (USEPA) (2009): Risk and Exposure Assessment to Support the Review of the SO_2 National Ambient Air Quality Standards: Final Report. Available http://www.epa.gov/ttn/naaqs/standards/so2/data/200908SO2REAFinalReport.pdf (accessed September 2014).

WHO (1997): Environmental Health Criteria 188 Oxides of Nitrogen. Second edition. Available: http://www.inchem.org/documents/ehc/ehc/ehc188.htm (accessed August 2014).

WHO (1999): Guidelines for Air Quality, World Health Organisation, http://www.who.int/peh/air/Airqualitygd.htm.

WHO (2003): Health aspects of air pollution with particulate matter, ozone and nitrogen dioxide. Report on a WHO Working Group Bonn, Germany 13-15 January 2003, WHO Geneva.

WHO (2005): WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulphur dioxide, Global update 2005, Summary of risk assessment, WHO/SDE/PHE/OEH/06.02.

WHO (2013): Review of evidence on health aspects of air pollution – REVIHAAP Project. Technical report. Available: http://www.euro.who.int/__data/assets/pdf_file/0004/193108/REVIHAAP-Final-technical-report-final-version.pdf. (accessed September 2014).

11. FORMAL DECLARATIONS

A declaration of the accuracy of the information contained in this Atmospheric Impact Report is included here. A declaration of the independence of the practitioners in the uMoya-NILU consultancy team that compiled this AIR is also included.

DECLARATION OF ACCURACY OF INFORMATION – APPLICANT

Name of Enterprise: uMoya-NILU Consulting (Pty) Ltd

Declaration of accuracy of information provided:

Atmospheric Impact Report in terms of Section 30 of the Act

I, Mark Zunckel [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 office is a criminal office in terms of section 51(1)(g) of this Act.

Signed at Durban on this 19th day of June, 2019

SIGNATURE

Managing Director – uMoya-NILU Consulting
CAPACITY OF SIGNATORY

DECLARATION OF INDEPENDENCE – PRACTITIONER

Name of Practitioner: Mark Zunckel

Name of Registered Body: South African Council for Natural Scientific Professionals

Professional Registration Number: 400449/04

Declaration of independence and accuracy of information provided:

Atmospheric Impact Report in terms of Section 30 of the Act

I, Mark Zunckel declare that I am independent of the applicant. I have the necessary expertise to conduct the assessment required for the report and will perform the work relating to 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 the 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 office is a criminal office in terms of section 51(1)(g) of this Act.

Signed at Durban on this 19th day of June, 2019

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SIGNATURE

Managing Director – uMoya-NILU Consulting
CAPACITY OF SIGNATORY