OLIFANT ESTATE TOWNSHIP DEVELOPMENT

Health Impact Study

SUBMITTED: 14 February 2022

ZABCOR Pty Ltd

434 Lois Ave

Waterkloof

Pretoria

✉ info@zabcor.com

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

DOCUMENT CONTROL

DOCUMENT IDENTIFICATION

PROJECT INFORMATION

Title	**OLIPHANT ESTATE TOWNSHIP DEVELOPMENT HEALTH IMPACT STUDY**
Date	14 February 2022
Classification	Company Confidential

DECLARATION BY THE SPECIALIST

I, ___Masekoameng Elizabeth_____, declare that –

- I act as the independent specialist in this application;
- I performed 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 declare that there are no circumstances that compromised my objectivity in performing this work;
- I have expertise in conducting the specialist report relevant to this application, including knowledge of the Act, Regulations and any guidelines that have relevance to the proposed activity;
- I complied with the Act, Regulations and all other applicable legislation;
- I have no, and did not engage in, conflicting interests in the undertaking of the activity;
- I undertake to disclose to the applicant and the competent authority 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 competent authority; and - the objectivity of any report, plan or document to be prepared by myself for submission to the competent authority;
- all the particulars furnished by me in this form are true and correct; and
- I realise that a false declaration is an offence in terms of regulation 48 and is punishable in terms of section 24F of the Act.

Signature of the Specialist

Zabcor Pty Ltd

Name of Company:

10 February 2021

Date

1. BACKGROUND

Oliphants Housing Estate (Pty) Ltd is proposing the construction of a mixed use residential development on the Remainder of Portion 18 of the Farm Roode Pan 70 in Kimberley in the Sol Plaatjie Local Municipality, Northern Cape Province. The property lies approximately 10km to the north of Kimberley between the Kamfers Dam and the Midlands Road, the total study area proposed for development is approximately 150 hectares.

The Oliphant Estate Township Development entails the construction of the 2886 housing units on the above mentioned property consisting of 175 freehold units and 2711 sectional title units consisting of High Density Residential, Lower Density Residential Nodes and a Business Node. Based on a pre-feasibility analysis, site identification, environmental screening process and market research studies undertaken, a favourable site has been identified for consideration and evaluation through an Environmental Impact Assessment (EIA) process.

Comments were received from the Environmental Department in Kimberley, indicating that they are concerned that the development may have some health impacts (i.e. smell) on the inhabitants due to its close proximity to the sewer works and recommended a Health Impact Assessment done to determine the extent of such impacts on the residents. Secondly, comments from the neighbouring landowner suggest that the residents may be impacted by pollution (in the form of PM, SO_2, NO_X and VOCs) from the brick manufacturing plant nearby. This brick manufacturing plant is part of the Kimberly Rehabilitation and Development (KRD) project.

1.1. About KRD project

Kimberley Rehabilitation and Development (KRD) project entails the development of (i) mixed-use (residential and commercial, etc.) at three sites: BMW, Colville and St Augustine; as well as (ii) quarries and brick manufacturing facilities at two sites: Vooruitzigt Quarry and Roodepan Quarry. *Clay* brick facility planned at Roodepan Quarry and a *Cement* brick facility at Vooruitzigt Quarry. Clay will be mined from the three mixed-use sites as well as from the Vooruitzigt Quarry. The sites are indicated in Figure 1.

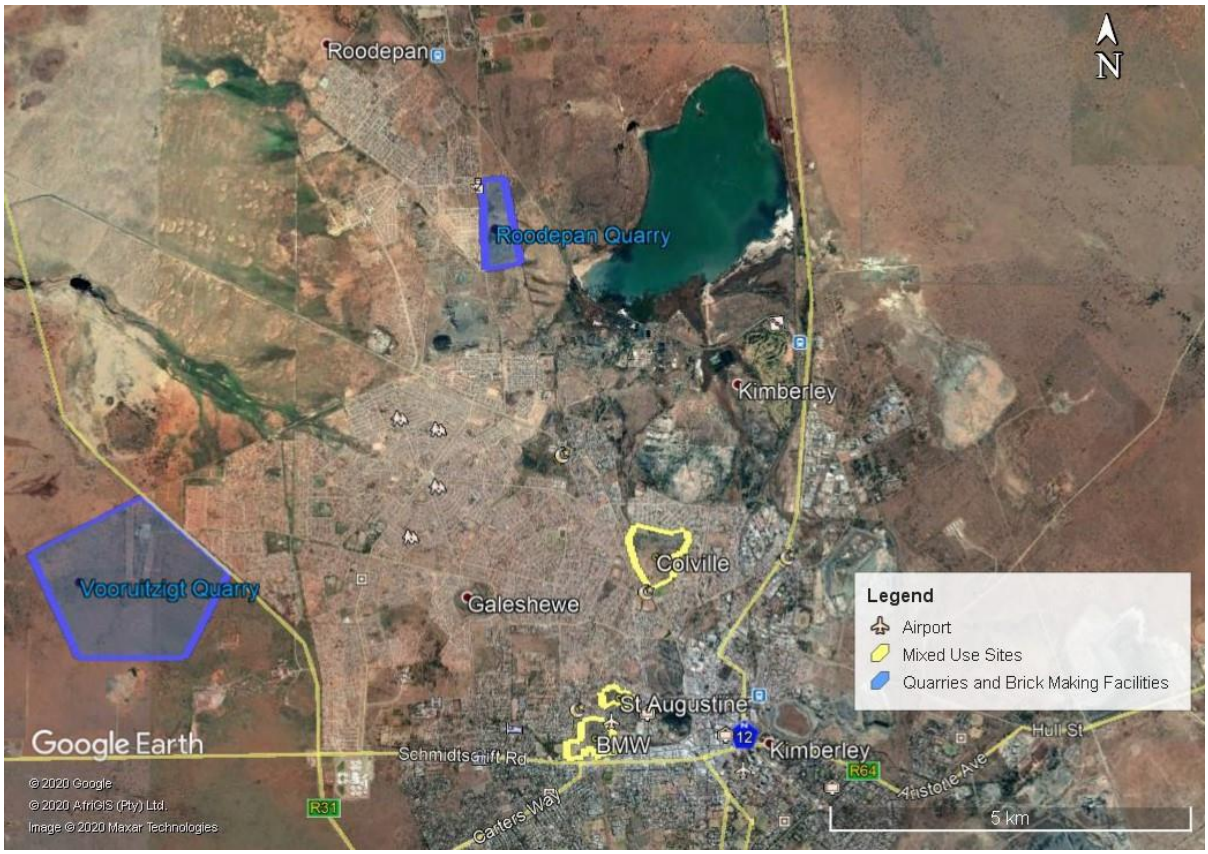

Figure 1: Locations of KRD project sites (Airshed Planning Professionals, 2021)

The development of mixed-use sites (commercial and residential areas) at the three sites of: BMW, Colville and St Augustine will primarily result in particulate matter emissions (thoracic particles with an aerodynamic diameter of less than 10 µm; PM_{10} and respirable particles with an aerodynamic diameter of less than 2.5 µm; $PM_{2.5}$) from the mining (reclaiming) of clay from the on-site dumps. There will also be emissions associated with the transportation of clay from the mixed landuse area to the quarries i.e. both tailpipe emissions and dust resuspension from poorly tarred or untarred roads.

Secondly, the Roodepan Quarry will primarily be used to process the clay removed from the three mixed-use sites in preparation for the Clay brick manufacturing. There will be stockpiling of coal and clay, screening of clay, blending of raw materials, materials handling, and vehicle entrainment on unpaved access roads. All these activities would give rise to particulate emissions (PM_{10} and $PM_{2.5}$) and while the clay brick manufacturing facility at the same quarry site (Roodepan Quarry) will give rise to gaseous emission such as Sulphur Dioxide (SO_2), Oxides of Nitrogen (NOx), Carbon monoxide(CO), Hydrogen Fluoride (HF) and volatile organic compounds (VOCs).

Lastly, the Vooruitzigt Quarry will be used to mine material for use in the cement brick making process, which will ultimately be used to supply building materials to the mixed-use developments. The quarry operations will include drilling and blasting as well as crushing and screening, materials handling, and vehicle entrainment on unpaved on-site roads. All these activities would give rise to particulate emissions (TSP, PM_{10} and $PM_{2.5}$) and to a lesser extent gaseous emissions (SO_2, NO_2, CO and HC).

The impacts of these emissions on the environment and consequently on the health of residents of the proposed Olifants Estate are assessed using previous impact reports as the basis. The results are presented in section 5 of this report.

1.2. About Homevale Waste Water Treatment Plant

Homevale wastewater treatment plant (WWTP) is located approximately 1 kilometre from the proposed Olifants Estate as shown in figure 2.

Figure 2: Locations of Homevale WWTP

There was no data regarding the size of the plant and the amount of waste water processed per day at this plant. Hence it was difficult for the consultants to predict the impacts. In the absence of such information, consultants relied on findings from impact studies done elsewhere and published in literature.

It should also be noted that this facility is currently not operational (based on communication with local stakeholders). Thus the impacts presented here are based on the assumption that the facility will be operational in future.

2. Legislative background

This air quality impact study was informed by legislative prescripts provided in the following legislation.

2.1. Listed Activities and Minimum National Emission Standards (MES)

The Minister responsible for environmental affairs has, in terms of Section 21 of the National Environmental Management: Air Quality Act of 2004 (NEM: AQA) (Government Gazette No. 27318), published a list of activities which result in atmospheric emissions and which are believed to have significant detrimental effects on the environment, human health and social welfare. Once listed on the notice, such an activity requires an Atmospheric Emission Licence (AEL) to operate. The Listed Activities and Minimum Emission Standards (MES) were first published on 31 March 2010 (Government Gazette No. 33064) with a revision of the schedule on the 22 November 2013 (Government Gazette No. 37054).

The activity concerned in this project i.e. establishment of a residential area is not a listed activity in accordance with Section 21 of the NEM: AQA. However, this activity is likely to be impacted by other NEM: AQA listed activities in the neighbourhood, such as Clay brick manufacturing.

2.2. National Ambient Air Quality Standards (NAAQS)

The Minister responsible for environmental affairs has in terms of section 9 of the NEM: AQA published the National Ambient Air Quality Standards (NAAQS) in December 2009 (Government Gazette 32816) and additional standards for particulate matter less than 2.5 µm in aerodynamic diameter ($PM_{2.5}$) was published in June 2012. The standards were developed for those pollutants that are of concern because they have proven detrimental health effects when inhaled. These include CO, NO_2, SO_2, benzene, lead (Pb), PM_{10}, $PM_{2.5}$, and ground level ozone (O_3), as listed in Table 1.

Table 1: National Ambient Air Quality Standards (NAAQS)

Pollutant	Averaging Period	Concentration (µg/m³)	Permitted Frequency of Exceedance	Compliance Date
Sulphur Dioxide (SO_2)	10 minutes	500	526	Immediate
	1 hour	350	88	Immediate
	24 hours	125	4	Immediate
	1 year	50	0	Immediate
Benzene	1 year	5	0	1 January 2015
Carbon Monoxide (CO)	1 hour	30000	88	Immediate
	8 hour[a]	10000	11	Immediate
Lead (Pb)	1 year	0.5	0	Immediate
Nitrogen Dioxide (NO_2)	1 hour	200	88	Immediate
	1 year	40	0	Immediate
Ozone (O_3)	8 hour[b]	120	11	Immediate
$PM_{2.5}$	24 hours	40	4	1 January 2016 till 31 December 2029
	24 hours	25	4	1 January 2030
	1 year	20	0	1 January 2016 till 31 December 2029
	1 year	15	0	1 January 2030
PM_{10}	24 hours	75	4	1 January 2015
	1 year	40	0	1 January 2015

Notes:
(a) Calculated on 1-hour averages.
(b) Running average.

When the levels of pollutants in the atmosphere exceed the NAAQs set out in the table above, then the air is considered unclean and unhealthy for human consumption. This means that any exceedance of NAAQS result in people living in that area not enjoying their constitutional right to the environment (air) that is not harmful to their health and wellbeing. This study assessed the impacts of KRD project on Olifants Estate residents by determining compliance to these standards in the Estate given various activities that are likely to impact air quality in the area.

2.3. Dust Control Regulations (NDCR)

The National Dust Control Regulations (NDCR) were published on 1 November 2013and present standard for acceptable dust-fall rates is set out in Table 2 for residential and non-residential areas. According to these regulations the dust-fall rates at the boundary or beyond the boundary of the premises where it originates cannot exceed 600 mg/m²/day in residential and light commercial areas; or 1 200 mg/m²/day in areas other than residential and light commercial areas. Implicitly, when dust-fall rates exceed these levels, they are likely to cause nuisance and potentially present a threat to human health.

Table 2: Acceptable levels of dustfall

Restriction Area	Dust-fall rate (D) (mg/m²/day, 30-day average)	Permitted frequency of exceeding dust fall rate
Residential	D < 600	Two within a year, not sequential months.
Non-residential	600 < D < 1 200	Two within a year, not sequential months

Note: The method to be used for measuring dust-fall rate and the guideline for locating sampling points shall be ASTM D1739: 1970, or equivalent method approved by any internationally recognized body

In addition to the dust-fall limits, the NDCR prescribe monitoring procedures and reporting requirements. This will be based on the measuring reference method ASTM 01739:1970 (or an equivalent method approved by any internationally recognised body) averaged over 30 days.

3. OBJECTIVES

The objective of this air quality impact study was to:

- To understand the potential health impacts of pollution from the Kimberly Rehabilitation and Development (KRD) project on residents of the proposed Olifants Estate development.
- To understand the potential health impacts of pollution from Homevale Waste Water Treatment Plant (WWTP) on residents of the proposed Olifants Estate development.

4. METHODOLOGY

4.1. Understanding exposure concentrations inside Estate Boundaries

The first step in understanding health impacts of pollution is to gather information about the type and concentration of pollutants in a given area of interest i.e. exposure concentrations. For air pollutants, exposure concentrations can be derived from two types of sources:

- Ambient air quality measurements undertaken in the area of interest, and/or
- Air dispersion modelling of all sources impacting the area of interest.

Currently, there is no air quality monitoring undertaken in the vicinity of the proposed development. Also, it was not feasible to undertake a detailed dispersion modelling to determine cumulative exposure concentrations of all pollutants that may affect the Estate. However, since the concerns raised were specifically in relation to KRD project as well as the local Wastewater Treatment Plant (WWTP); exposure concentration analysis done in this study focused only on the impact of these two developments.

4.1.1. Pollutant concentrations associated with KRDP

To estimate concentrations of air pollutants at Olifants Estate associated with KRD project, we used KRD Air Quality Assessment report produced by Airshed Planning Professionals Pty Ltd (2021). We than applied Geographic Information Systems (GIS) software to superimpose the dispersion model output (provided in the KRDP Air Quality Assessment Report section 4.3) on the Estate boundary map provided by the client. This enabled us to estimate the concentrations inside the estate. The following pollutants were analysed as these were the only pollutants considered in the of KRD project air quality assessment report:

- Particulate Matter (PM_{10}) and associated dust
- Sulphur Dioxide (SO_2)
- Hydrogen Fluoride (HF)

4.1.2. Pollutants concentrations associated with WWTP

To estimate concentrations of odour causing pollutants at Olifants Estate, we reviewed literature on dispersion and transport of H_2S from WWTPs. Although there are over 1000 odour causing pollutants, we focused on H_2S since it is the most commonly used indicator of odour in WWTPs

The aim was to understand how far can odours associated with H_2S travel and whether or not Olifants Estate falls within that travel distance range. We relied on literature values because we did not receive any air quality impact report from the WWTP.

Additionally, we had telephonic interviews with one resident who resides near the proposed Olifants Estate to obtain his experiences of pollution and odours from the WWTP which we believe would be representative of what residents of the proposed Olifants Estate might experience. This also allowed us to improve our understanding of odours from the local WWTP because odour detection and impacts is very subjective and therefore relying on estimated emissions concentrations alone is not always sufficient.

4.2. Quantification of health impacts

In addition to highlighting potential health impacts using the methodology in 4.1 above, we quantified the impacts in respect of the following critical health endpoints:

- Morbidity
    - Cardiovascular hospital admissions (associated with PM)
    - Respiratory hospital admission (Associated with PM)
    - Respiratory hospital admissions (asthma-related, in association with SO_2)

The quantification of health impacts involved the use of relative risk ratios obtained from literature against the exposure concentrations obtained using the methodology section 4.2.

Firstly, the potential number of deaths or hospital admissions (cases) associated with the concentration of a pollutant contributed by KRD project was calculated using the following equations and methods of the World Health Organization.

$$I = AF \times P \times B / 10 \qquad \text{(Equation 1)}$$

Where:

I	Potential morbidities per year due to exposure to the pollutant
AF	The attributable fraction of morbidities due to exposure to the pollutant. See details below.
B	The population incidence of morbidity (hospitalisation rates per 1 000 people): Sourced from Stats SA for mortality and medical aid reports for morbidity.

P	Size of the exposed population (number)

The AF is the fraction of the health effect incidence in the exposed population that could be prevented if exposure to the pollutant was eliminated. AFs assist in answering the question, *"of the above mentioned incidences/cases of hospital admissions, how many of those will be associated with exposure to pollution at given concentrations?".*

AF is calculated as follows:

$$AF = \frac{(RR-1)}{RR} \qquad \text{(Equation 2)}$$

Where:

RR	Risk ratio between pollutant concentration and clean air (pollutant concentration below the no-harm threshold).

For those outcomes that have a constant RR for a given change in concentration,

$$RR(conc) = RR_0^{(conc-conc_{no\ harm})\ /\ \Delta conc_0} \qquad \text{(Equation 3)}$$

where RR_0 is the risk ratio for change in concentration $\Delta conc_0$, e.g. 1.043 for an increase of 10 µg/m^3 in the case risk of the contribution of sulphate aerosols to the risk of all-cause deaths.

The following RR values are available in literature and were used in this study for different pollutants and health endpoints:

Table 3: Examples of Risk Ratios used in the quantification of health impacts

Health outcome for PM2.5 exposure	RR per 10 µg/m3 PM2.5 increase
Mortality	1.0101 - 1.0123
Cardiovascular admissions	1.0091 - 1.0100
Respiratory admissions	1.0111 - 1.0190
Health outcomes for short-term SO_2 exposure	**RR per 10 ppb SO2 increase**
Asthma admissions: all ages	1.040

5. RESULTS

5.1. Exposure concentrations inside Estate Boundaries

The following sections provides the outcomes of exposure concentrations analysis. The exposure concentrations are presented separately for KRD project and for Homedale WWTP. This separate analysis was acceptable because these two developments are not emitting the same pollutants, hence there was no need to combine the exposure concentrations to evaluate cumulative impacts.

5.1.1. Potential Pollution exposure associated with KRD project

As indicated earlier, the concentrations of air pollutants at Olifants Estate associated with KRD project were assessed by using GIS to superimpose the dispersion model output (provided in the KRD project Air Quality Assessment Report section 4.3 on the Estate boundary map provided by the client. This enabled us to estimate the concentrations inside the estate. The following maps show exposure concentrations of $PM_{2.5}$, PM_{10}, SO_2, HF and dust inside the estate, associated with KRD project.

a) PM concentrations

KRD project Air Quality Assessment Report (Airshed Planning professionals, 2021) provides dispersion modelling maps showing daily ground level concentrations of PM_{10} and $PM_{2.5}$ (99^{th} percentile) associated with various land-uses in the KRDP project. These were superimposed over Olifants Estate boundary map in order to determine predicted PM concentrations inside estate. The results are shown in Figure 1 below:

PM_{10} : Design mitigated **$PM_{2.5}$: Design mitigated**

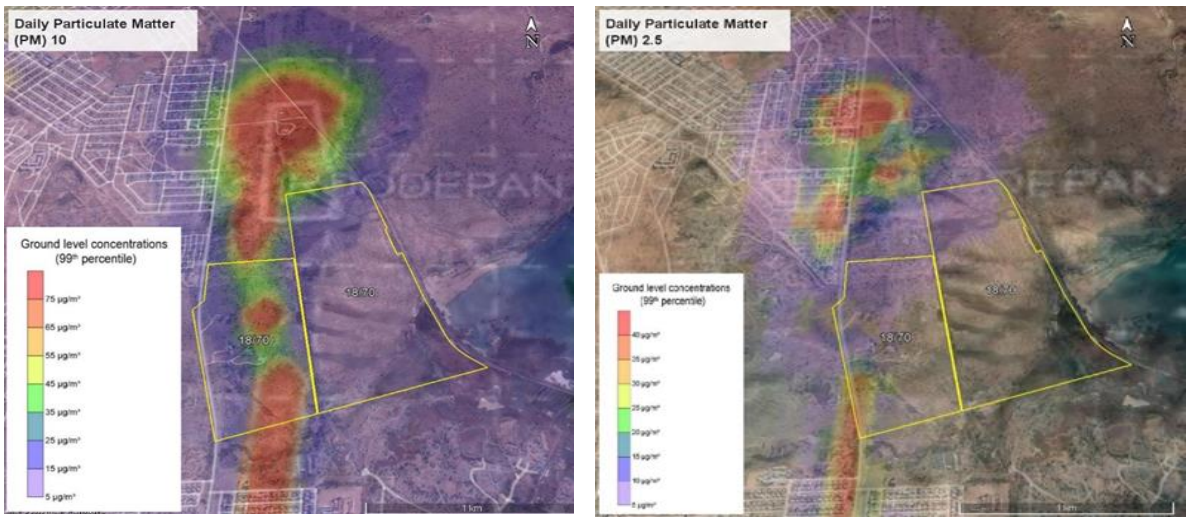

Figure 3: Model predicted daily PM10 (left) and PM2.5 (right) concentrations relative to Olifants Estate boundaries.

The results show that the Estate will be impacted by PM_{10} and $PM_{2.5}$ emissions associated with KRD project. Specifically, the KRD project will result in $PM_{2.5}$ concentrations of above 5ug/m^3 the East wing of the Estate, and above 40ug/m^3 in the West wing of the Estate. 40ug/m^3 is the current (2022) $PM_{2.5}$ limit (or NAAQ Standard) and the 2030 limit is 20ug/m^3. This exceedance of $PM_{2.5}$ limit (or NAAQ Standard) in the West wing of the Estate means that people living in this wing are likely to suffer a myriad of health impacts associated with high $PM_{2.5}$ such as cardiovascular diseases and lower and upper respiratory health issues.

Furthermore, the results show that the KRD project will result in PM_{10} levels that are above 35ug/m^3 in the East wing of the Estate and above 75ug/m^3 in the West wing of the Estate. 75ug/m^3 is the current PM_{10} limit (or NAAQ Standard). Thus, PM_{10} levels in exceedance of 75ug/m^3 will subject people in the West wing of the estate to health impacts such as bronchitis, coughing, high blood pressure, heart failures etc., associated with high PM_{10} .

It is important to note that the abovementioned exceedances of pollution standards will occur even under the design mitigation measure scenario which entail implementation of measures that KRD is committed to. These include application of water sprays to achieve a 50% control efficiency (CE) at all materials handling points, at crushing and screening points and on unpaved roads(on-site). Hence there was no need to present the mitigation vs unmitigated scenarios.

b) SO_2 concentrations

KRD Air Quality Assessment Report (Airshed Planning professionals, 2021) provides dispersion modelling maps showing daily ground level concentrations of SO_2 (99^{th} percentile) associated with various land-uses in the KRD project. In particular, SO_2 emissions are associated with clay brick manufacturing at Roodepan quarry. The said dispersion modelling maps were superimposed over Olifants Estate boundary map in order to determine predicted SO_2 concentrations inside estate. The results are shown in Figure 4 below for unmitigated and mitigated scenarios:

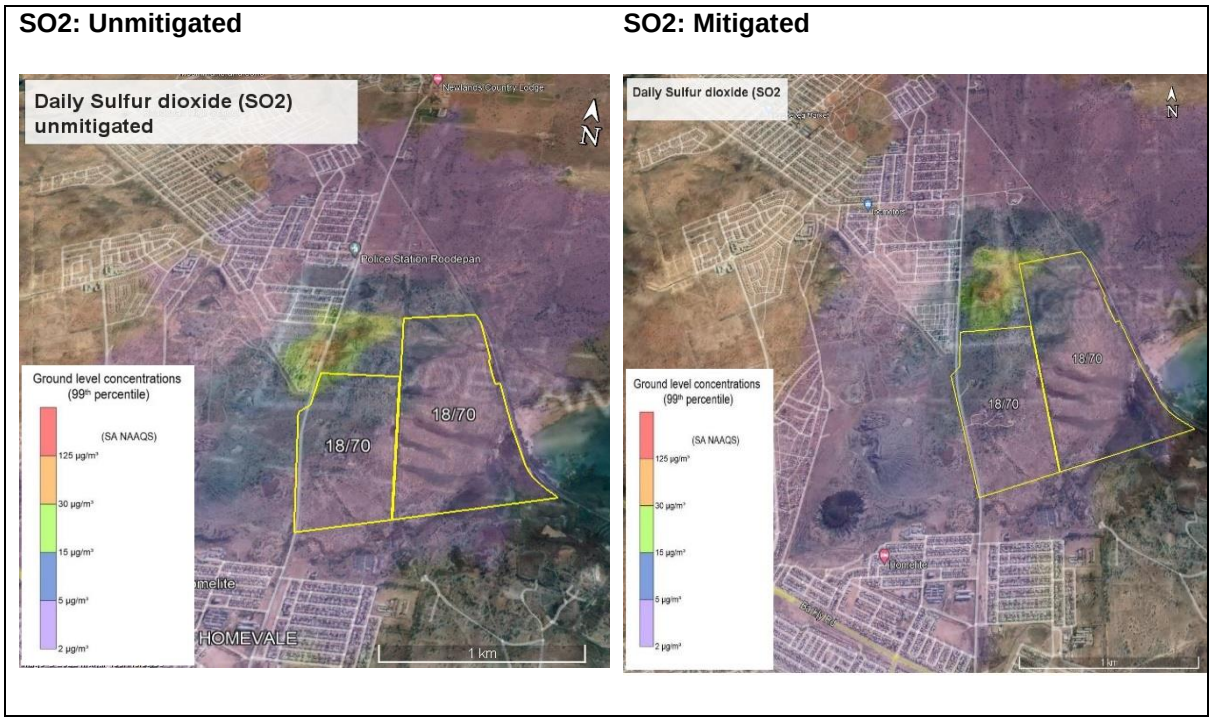

Figure 4: Model predicted daily SO2 concentrations relative to Olifants Estate boundaries under unmitigated (left) and mitigated (right) scenarios

These results are showing that the KRD project will result in SO_2 concentrations of above 15ug/m^3 the East wing of the Estate, and above 5ug/m^3 in the West wing of the Estate. All these concentrations/levels are well within acceptable levels (or NAAQ standard of 125ug/m^3) even under unmitigated scenario. This means that it can be expected that SO_2 concentrations in the Estate will be acceptable and not cause serious health impacts.

However, it should be noted that these predicted SO_2 levels were based on emissions from clay brick manufacturing only and does not take into account cumulative emissions from all sources on the area. This is due to lack of baseline data from all sources in the area.

c) HF concentrations

KRD project Air Quality Assessment Report (Airshed Planning professionals, 2021) provides dispersion modelling maps showing daily ground level concentrations of HF (99th percentile) associated with various land-uses in the KRD project. In particular, HF emissions are associated with clay brick manufacturing at Roodepan quarry. The said dispersion modelling maps were superimposed with Olifants Estate boundary map in order to determine predicted HF concentrations inside estate. The results are shown in Figure 5 below. Note that no mitigation measures were proposed in KRD impact assessment for this pollutant since concentration levels were within acceptable levels.

HF: Unmitigated

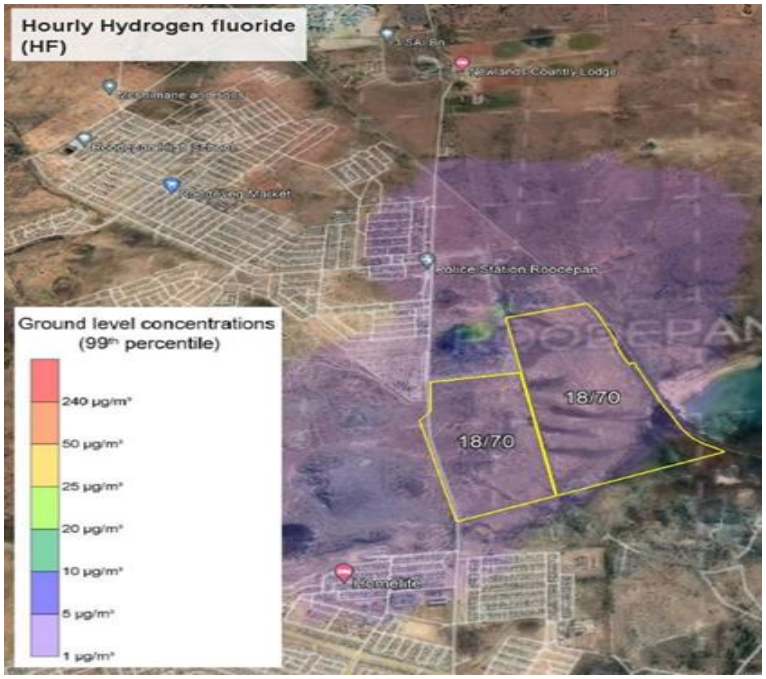

Figure 5: Model predicted hourly HF concentrations relative to Olifants Estate boundaries (no mitigation proposed)

These results are showing that the KRD project will result in HF concentrations that are approximately 1-5 ug/m^3 in both East and West wings of the Estate. These concentrations/levels are well within the recommended limit values 240 µg/m3 set by the Californian OEHHA. This means that it can be expected that HF concentrations in the Estate will be within acceptable standards and therefore may not cause serious health impacts.

However, it should be noted that these predicted HF levels were based on emissions from clay brick manufacturing only and does not take into account cumulative emissions from all sources on the area. These is due to lack of baseline data from all sources in the area.

d) Dust

KRD project Air Quality Assessment Report (Airshed Planning professionals, 2021) provides dispersion modelling maps showing daily dust-fall rates associated with various land-uses in the KRD project, in relation to acceptable dust-fall levels set out in the National Dust Control Regulations (NDCR). The said dispersion modelling maps were superimposed over Olifants Estate boundary map in order to predict dust-fall within the Estate boundaries. The results are shown in Figure 6 below.

Dust: Design mitigated

Figure 6: Model predicted daily dust fallout rates relative to Olifants Estate boundaries

These results are showing that the KRD project is likely to result in dust levels of above 1200 mg/m^2/day in the East wings of the Estate. These levels are way above the acceptable level of 600 mg/m^2/day in residential areas. This means that it can be expected that dust levels in the East wing of the Estate will create nuisance to the residents, causing community complaints.

e) Conclusions regarding pollution impacts of KRD project

From dispersion modelling maps above, it is clear that pollution from KRD project will reach the residents of Olifants estate. Residents will be exposed to different concentration levels for different pollutants as shown in the table below.

Table 4: Exposure concentrations in relation to ambient air quality standards

Pollutant	Acceptable levels	Minimum exposure levels in the Estate	Maximum exposure levels in the Estate	Levels acceptable/not acceptable
Sulphur dioxide (SO_2)	125 ug/m^3	5 ug/m^3	10 ugm^3	Acceptable
Hydrogen Fluoride (HF)	240 ug/m^3	1ug/m^3	5ug/m^3	Acceptable
Particulate Matter 2.5r ($PM_{2.5}$)	40 ug/m^3	5ug/m^3	40ug/m^3	Not acceptable
Particulate Matter 10 (PM_{10})	75 ug/m^3	5ug/m^3	75ug/m^3	Not acceptable
Dust	600 mg/m^2/day	50mg/m^3	1200mg/m^3	Not acceptable

Pollutants of concern: Although all modelled pollutants will reach the boundaries of Olifants Estate, only PM_{10}, $PM_{2.5}$ and dust levels will exceed acceptable levels inside the Estate boundaries. This means that should the proposed KRD project continue, there will be some negative impacts to the most sensitive members of Olifants Estate community associated with PM_{10} and $PM_{2.5}$. Such impacts would include cardiovascular diseases and lower and upper respiratory health issues. The severity of these PM impacts is quantified in section 5.2.

Pollution sources of concern: The predicted exceedances in PM, $PM_{2.5}$ and dust in the Estate are mainly associated with clay brick manufacturing and vehicle emissions as haul trucks are expected to transport raw materials from other parts of KRD project to the Roodepan quarry for clay brick manufacturing.

Development area of concern: What is also clear from the dispersion modelling maps above is that the East wing of the Estate is least impacted by pollution. In fact, in the East wing, all pollutants meet acceptable daily limits pollution levels. This means, should the Estate development continue, only the East wing and some parts of the West wing will be recommendable for residential purposes. The West wing should where possible be resized, rezoned or avoided in order protect prospecting residents from the impact of PMs and dust as the levels of these pollutants exceed acceptable limits in this wing.

Note: the above analysis is ONLY true on condition that the proposed KRD project goes ahead as planned.

5.1.2. Pollution associated with WWTP

a) Introduction: Health impacts of WWTPs

The operations of wastewater treatment plants (WWTP) usually involve the release into the atmosphere of malodorous substances with the potential to reduce the quality of life of people living nearby. In this type of facility, anaerobic degradation processes contribute to the generation of hydrogen sulphide (H_2S), often at quite high concentrations; thus, the presence of this chemical compound in the atmosphere can be a good indicator of the occurrence and intensity of the olfactory impact in a specific area (Fernandos, 2012).

H_2S affect communities both as a nuisance (due to odour) and as a health-affecting pollutant. According to the World Health Organization (WHO, 2000, In Augustus, 2019) the presence of H_2S in the atmosphere with concentrations over 15 mg/m^3 can cause adverse effects to human health, from simple respiratory problems to lethal complications when exposing individuals to concentrations over 1400 mg/m ^{3}. As a nuisance, H_2S can cause odour discomfort at low concentrations (about 0.7 µg/m^3), equivalent to 0.00047 ppm at 25 °C and 1 atm (Tchobanoglous et al., 2013) (In Augustus, 2019).

b) Potential impacts of Homevale WWTPs on local communities

In order to understand concentrations of odorous pollutants emitted from WWTP, we reviewed literature (albeit very scares) on dispersion and transport of H_2S (as an odour indicator pollutant) from WWTPs. One of the few studies that modelled atmospheric dispersion of H_2S from two WWTPs in Brazil showed that odour plumes (at concentrations above the recommended 0.7ug/m3) typically reached over 2-4 km from their sources and strongly affected by atmospheric stability/instability conditions for the events analysed (Augustus et al, 2019). Moreover, areas at the vicinity of the WWTP were affected by levels of H_2S that may cause health problems to individuals, in addition to odour discomfort and other mild outcomes.

Meanwhile, our GIS analysis suggest that Olifants Estate is located only 0.8 kilometres from the local Homevale WWTP (see Figure 2). Accordingly, drawing from the above suggestions in literature, it can be expected that odorous pollutants from Homevale can reach Olifants Estate boundaries and be felt by residents. This will however depend on a number of things such as:

- Prevailing wind direction & windspeed
- Temperature
- Humidity

- Operating conditions at the WWTP
- Amount of sewage processed at the treatment plant
- Sensitivity of residents to odour
- Etc.

Given the direction of the proposed Olifants Estate to Homevale WWTP (North westerly) shown in the map above, it can be anticipated that odours from Homevale will be felt the most in the Estate during times where the wind direction is from South-easterly and Easterly directions. According to seasonal wind roses obtained for the year 2021 (Figure 7), these South easterly and Easterly winds will occur this is 5% of the time in a year, mainly in Autumn months.

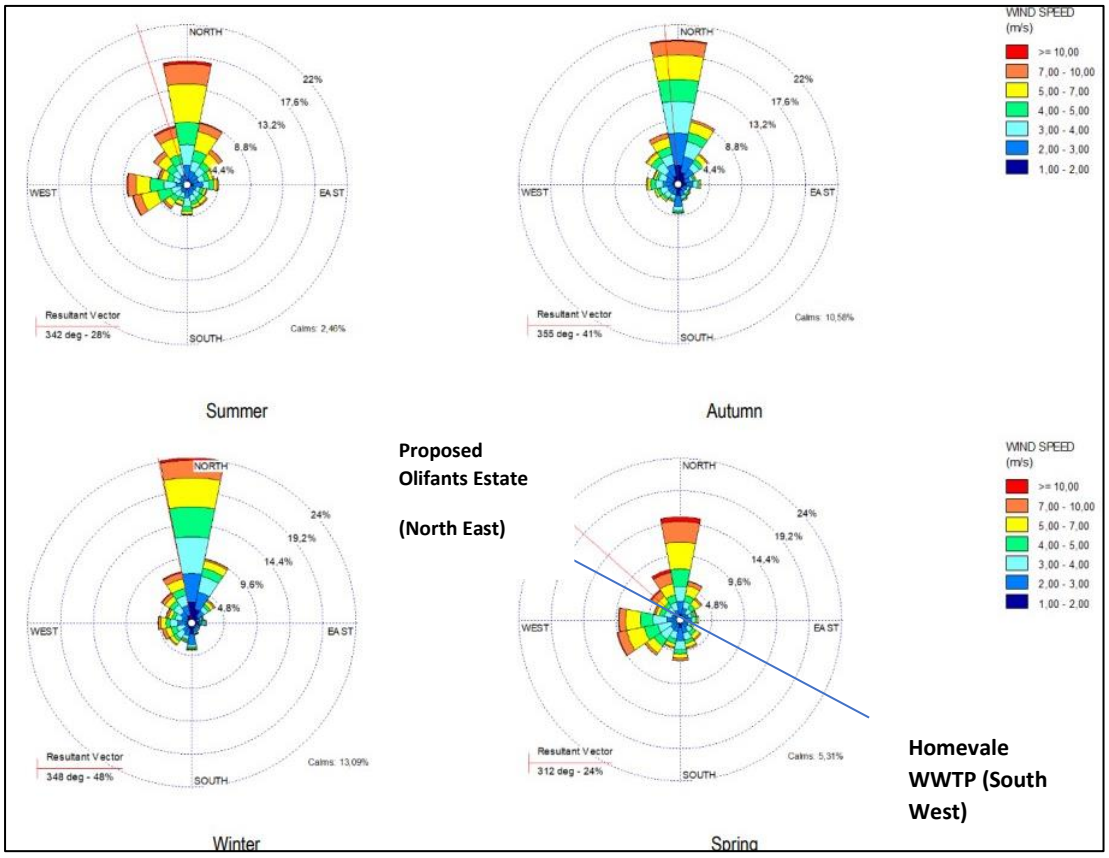

Figure 7: Seasonal Wind roses (Airshed Planning Professionals, 2021) showing the predominant wind direction, and direction of Homevale to the proposed Olifants Estate.

Based on wind roses above, it can be expected that residents of the proposed Estate will have the wind-driven odours detected only 5% of the time in a year. Meaning, that although they may not experience odours daily but on certain days when the wind direction is from the direction of the plant which is 5% of the time.

c) Interviews with locals

As part of odour assessment, we interviewed one of the persons who live in the Northern side of Homevale WWTP. They confirmed that although the plant is currently not operational, during years where the plant was operational, they would periodically detect odour, especially on days where the wind direction is from the pant (southerly). The said interviewee resides approximately 3km away from the plant, which is a longer distance compared to the proposed Olifants Estate (i.e. 0.8 km). This means that Olifants Estate residents are likely to experience more odour episodes than the interviewed persons since the Estate is closer to the plant.

d) Conclusions regarding pollution impacts of Homevale WWTP

Based on the following data:

(i) Olifants Estate is located only 0.8 kilometres from the local Homevale WWTP,

(ii) Literature suggests that detectable odour plumes can reach over 2-4 km from their sources depending on atmospheric stability (Augustus et al, 2019), and

(iii) One person interviewed who confirmed that they were able to detect odours from Homedale WWTP 3km away in the almost same direction as that of the proposed Estate;

We conclude that it is possible for residents of the proposed Olifants Estate to detect odours from Homevale, should the plant resume operations.

Note: the above analysis is ONLY true on condition that Homevale WWTP is operational.

5.2. Quantification of health impacts

We used the predicted exposure concentrations in section 4 above and applied literature based dose-response functions in order to quantify health impacts associated with PM & SO_2 levels that are likely to occur inside the Estate as a result of KRD project. This quantification focused only on PM & SO_2 since it is common practice to use few *unrelated* pollutants for health impact quantification in order to avoid double counting of health impacts. Health impacts of PM and SO_2 are unrelated, hence these two are commonly used in additions to Ozone (O_3) where ozone data is available, in health impacts studies. It is also a recommended practice to use $PM_{2.5}$ instead of PM_{10} because $PM_{2.5}$ has more severe health impacts than PM_{10}. Thus, for this health impact quantification/assessment we considered average $PM_{2.5}$ and SO_2 concentrations inside the West and East wings of the Estate as follows:

- $PM_{2.5}$ concentrations of 40ug/m^3 in the East wing and 5ug/m3 in the west wing of the Estate.
- SO_2 concentrations of 5ug/m^3 the East wing of the Estate, and 15ug/m^3 in the West wing of the Estate.

We used the methodology outlined in section 4.2 to quantify the impacts. This methodology requires information on:

- Population exposed
- Incidence rates
- Risk ratios as presented in section 4.2 (equation 2).

a) Population exposed

The Olifants Estate is expected to have 2886 residential units. We assumed occupancy of 3 persons per unit; which means the total population in the Estate would be estimated at 8658 persons. We further assumed an equal split of population between West wing and East wing. This assumption was made only to enable the reader to compere the magnitude of impact for each wing of the Estate since the two wings are not equally impacted by pollution. Although this equal split may not be the case in reality, this assumption is fair for the purpose of comparison without altering the total population size value.

With the above assumptions, the assessment is based on 2886 units in the Estate with 1443 units in each wing. With the assumed occupancy of 3 persons per unit, the total population in the Estate was estimated at 8658 persons; with each wing hosting 4329 persons. This population data for calculation of health impacts is summarized in the table below, along side exposure concentrations:

Table 5: Baseline data used for quantification of health impacts

Pollutant	Max. concentrations East wing (ug/m^3)	Estimated population affected	Max concentrations West wing (ug/m^3)	Estimated population affected
$PM_{2.5}$	40	4329	5	4329
SO_2	15	4329	5	4329

b) Current incidence rates of health impacts

For the purpose of this study, we quantified the potential health impacts in respect of the following critical health endpoints:

- Cardiovascular hospital admissions (associated with $PM_{2.5}$)
- Respiratory hospital admission (associated with $PM_{2.5}$)
- Respiratory hospital admissions (asthma-related, in association with SO_2)

Incidence rates were therefore estimated based on the rate of hospital admissions for the abovementioned illnesses. Data on hospital admissions related to cardiovascular diseases, respiratory illnesses and asthma was derived from Econex (2015) report on private hospital utilisation. The data were limited to private hospitals, which serve mostly medical aid beneficiaries and did not include public hospital admissions. This required us to extrapolate private hospitalisation data to public/South Africa-wide hospitalisation rates by applying the ratio between private hospital beneficiaries (usually medical aid beneficiaries) and public hospital beneficiaries. According to the Council for Medical Schemes, the number of medical aid beneficiaries was 8.878 million in December 2016 (Leboho and Sehloho 2017), which is 16 per cent of the total population of 55 653 654 (Stats SA 2016a).

Based on the above ratio as well as incidence value provided by Econex (2015), the national incidence rates of cardiovascular diseases, respiratory illnesses and asthma is as presented in Table 6. These national values were converted into a percentage value that can be used to predict local (Olifants Estate) incidence rates which are also presented in the same table.

Table 6: Extrapolated incidence rates of health impacts

Health endpoint	National incidence rate (n)	National incidence rate (%)	National incidence rate (%)	Local (Estate) incidence rate (n)
Cardiovascular hospital admissions	1 659 375	3	3	131
Respiratory hospital admissions	928 125	2	2	73
Asthma-related admissions	84 375	0,2	0,2	7

c) Quantified health impacts

Using equation 1 in section 4.2 and the assumptions presented above, we were able to quantify the potential health impacts of KRD project on Olifants Estate Residents. The results are presented in Table 7 below.

Table 7: Quantified health impacts associated with pollution levels in East wing of Olifants Estate

Pollutant (highest concentration)	Health endpoint	All cause Incident rate (Local)	RR	Predicted number of pollution-related cases (n)	Predicted number of pollution-related cases (%)
$PM_{2.5}$	Cardiovascular hospital admissions	131	2	65	1.5%
	Respiratory hospital admissions	73	2	36	0.8%
SO_2	Asthma-related admissions	7	0.12	<1	<1

Table 8: Quantified health impacts associated with pollution levels in the West wing of Olifants Estate

Pollutant (highest concentration)	Health endpoint	All cause Incident rate/yr (Local)	RR	Predicted number of pollution-related cases/yr (n)	Predicted number of pollution-related cases/yr (%)
$PM_{2.5}$	Cardiovascular hospital admissions	131	0,25	<1	<1
	Respiratory hospital admissions	73	0,25	<1	<1

SO_2	Asthma-related admissions	7	0,04	<1	<1

6. SUMMARY & CONCLUSIONS

6.1.1. KRD project impacts

Pollutants of concern: Although all modelled pollutants will reach the boundaries of Olifants Estate, only PM_{10}, $PM_{2.5}$ and dust levels will exceed acceptable levels inside the Estate boundaries. This means that should the proposed KRD project continue, there will be some negative impacts to the most sensitive members (usually elderlies and children) of Olifants Estate community associated with PM_{10} and $PM_{2.5}$. Such impacts would include cardiovascular diseases and lower and upper respiratory health issues.

Severity of impacts: Section 5.2 provides a quantification of health impacts for the East and West wing of the Estate. The results shows that in the East wing, pollution from KRD project is likely to cause approximately 65 hospital admissions and 36 hospital admissions associated respiratory illnesses and cardiovascular diseases per year. These numbers represent approximately 2% of the population of the Estate. However, the West wing of the plant does not show any health impacts on residents. This is because although pollution from KRD project will reach these part of the Estate, the concentrations of pollutants will meet acceptable levels in this wing.

Pollution sources of concern: The predicted exceedances in PM_{10}, $PM_{2.5}$ and dust in the Estate are mainly associated with clay brick manufacturing and vehicle emissions as haul trucks are expected to transport raw materials from other parts of KRD project to the Roodepan quarry for clay brick manufacturing.

Development area of concern: What is also clear from the dispersion modelling maps above is that the East Wing of the Estate is least impacted by pollution. In fact, in this wing (East wing) all pollutants meet acceptable daily limits pollution levels in this wing.

6.1.2. Homevale WWTP impacts

Olifants Estate is located only 0.8 kilometres from the local Homevale WWTP, and literature suggests that detectable odour plumes can reach over 2-4 km from their sources depending on atmospheric stability (Augustus et al, 2019), size of the treatment facility and WWTP operating conditions. Meanwhile, one person interviewed confirmed that they were able to

detect odours from Homedale WWTP 3km away in the almost same direction as that of the proposed Estate. Hence we conclude that it is possible for residents of the proposed Olifants Estate to detect odours from Homevale, should the plant resume operations.

7. Recommendations

Given the potential impacts of KRD project on the East wing of the Estate, it is proposed that should both projects (KRD and Olifants Estate development) go ahead, efforts should be made to reduce or where possible avoid occupancy of the West wing of the Estate. Occupancy of the West wing should be limited to areas where PM levels are in compliance with NAAQS. These are all area that are not red in figure Figure 3 and Figure 6. The East wing of the Estate is most preferred from air pollution point of view, for the protection of human health from the effects of KRD project.

Given the potential, though short term impacts from Homevale WWTP, we recommend that should both projects (Homevale & Olifants Estate development) resume, the WWTP should put measures in place to minimise odours. While there are various operational measures that can be deployed by WWTPs to reduce odours, each measure should be evaluated for adequacy based on a thorough assessment of the configuration, operational designs and technological feasibility for a specific plant.

------END----

8. REFERENCES

1) Airshed Planning proffesionals, 2021, Air Quality Impact Assessment for the proposed Kimberley Rehabilitation and Development Project, Report No: 20NGS01 of February 2021.
2) Augusto, M.R., Campos, B., Carvalho, V.S.B. and Calheiros, H.C., 2020. Modeling of H 2 S dispersion in Brazil with Aermod: Case study of water resource recovery facility in south of Brazil. Revista Brasileira de Meteorologia, 34, pp.497-504.
3) Econex. 2015. Private hospital expenditure and relation to utilisation – observations from the data. Commissioned by the Hospital Association of South Africa (HASA).
4) Leboho M and Sehloho M. 2017. Contribution Increases and the CPI: Medical Schemes Utilisation Trends in 2016. Council for Medical Schemes' CMS News (2):9-10.
5) Llavador Colomer, F., Espinos Morato, H. and Mantilla Iglesias, E., 2012. Estimation of hydrogen sulfide emission rates at several wastewater treatment plants through experimental concentration measurements and dispersion modeling. Journal of the Air & Waste Management Association, 62(7), pp.758-766.
6) Stats SA. 2016a. Community Survey 2016 Statistical release P0301. Pretoria: Statistics South Africa. http://cs2016.statssa.gov.za/
7) Stats SA. 2016b. Community Survey 2016 Provinces at a glance. Report 03-01-03. Pretoria: Statistics South Africa. http://cs2016.statssa.gov.za/