Rapid Appraisal Health Impact Assessment for the Proposed Platinum Pride Crematorium in Cape Town

Rapid Appraisal Health Impact Assessment

SES01

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Project Name:	Proposed Establishment of a Crematorium Facility on Erf 2433, Montague Gardens, City of Cape Town Metropolitan Municipality
Report Name:	Rapid Appraisal Health Impact Assessment Report
Report Version:	Final Report
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Prepared By:	Vumile Ribeiro and Dikeledi Mokotong Environmental Health Consultant Niara Environmental Consultants (Pty) Ltd Palm Place Office Park No. 22 Bram Fischer Drive Linden, Johannesburg Email: info@niara.co.za

I, Vumile Ribeiro as duly authorised representative of Niara Environmental Consultants (Pty) Ltd., hereby confirm my independence (as well as that of Niara Environmental Consultants (Pty) Ltd) and declare that neither I nor Niara Environmental Consultants (Pty) Ltd. have any interest, be it business, financial, personal or other, in any proposed activity, application or appeal in respect of Ikamva Green Holdings T/A Platinum Pride, other than fair remuneration for work performed, specifically in connection with the Environmental Licensing Process at the proposed Platinum Pride Crematorium.

Specialist Declaration of Independence

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I Vumile Ribeiro, as duly authorised representative of Niara Environmental Consultants (Pty) Ltd., hereby confirm my independence and declare that I:

- I act as the independent specialist in this application.
- I 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 declare that there are no circumstances that may compromise my objectivity in performing such 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 will comply with the Act, regulations, and all other applicable legislation.
- I have no, and will 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 furnished by me in this form are true and correct.
- I realise that a false declaration is an offence in terms of Regulation 71 and is punishable in terms of Section 24F of the Act.

Signature of the Specialist:	V. Ribeiro
Designation:	Environmental Health Consultant
Qualifications:	Post Graduate Degree (Hons): BSoc Sci Environmental Analysis and Management
Name of company:	Niara Environmental Consultants (Pty) Ltd
Experience (years):	Fifteen (15)
Date:	September 2022

Executive Summary

Ikamva Green Holdings, trading as Platinum Pride, are in the process of obtaining the necessary permissions to commission a crematorium at 55 Stella Road in Montague Gardens, Cape Town. The crematorium is envisioned to be commissioned in two phases: Phase 1, which includes the installation of 2 cremators, and Phase 2, which includes the installation of an additional 4 cremators. Each cremator has the capacity to cremate 24 cadavers in a 24-hour period. This means that the crematorium, after commissioning Phases 1 and 2, will have a maximum cremation capacity of 144 cadavers per day.

The existing warehouse facility is intended to be refurbished, to accommodate the crematorium and associated infrastructure. The proposed scope of works includes the renovations of the existing warehouse facility as follows:

- Installation of 6 x BA2 cremators (manufactured under a license from Johnson Thermal Engineering (JTE)) specifications include: Locally manufactured and distributed in South Africa; Chamber 1: starved combustion primary chamber cremator, ensuring gas velocities are reduced, resulting in lower particulate pickup; Chamber 2: cremation process begins, from 600°C rapidly rising to control at 850°C or higher to completely combust gases and odours before exiting the stack; Provides 2 seconds of high temperature exhaust gas residence time, to ensuring low carbon monoxide emission and total combustion of complex volatile organic compounds; Cremators: equipped with an ejector in base of the cremator stack to aid with the drafting to maintain a slight negative pressure within the primary chamber, to ensure that no gases or noxious fumes are emitted into the cremator machine room when the door is opened; designed to meet the Air Emission requirements for new plants as specified in NEM:AQA), (refer to Appendix L).
- Liquefied Petroleum Gas (LPG) tanks (fuel source for furnaces), approximately 80m3.
- 3 x reefer coolers and one cool room. Each reefer can take 60 units, in total.
- Superficial modifications to the inside of the interior and aged exterior (including 6 x chimney stacks approximately 0.35m, approximately 6m's above the nearest building.

The use of Health Impact Assessments (HIAs) is a relatively new process in South Africa that is designed to ensure that often-overlooked or unanticipated health impacts are considered in proposed policies, programs, projects or plans. HIAs offer practical recommendations to minimise negative health risks and maximize health benefits, while addressing differential health impacts on vulnerable groups of people.

Methodology

A HIA is a practical, multi-disciplinary process, combining a range of qualitative and quantitative evidence in a decision-making framework. A HIA seeks to identify and estimate the lasting or significant changes of different actions on the health status of a defined population. The methodology of this HIA was based on the Good Practice Note (GPN) for HIAs as supported by the International Finance Corporation (IFC). The IFC has published a set of

Performance Standards (PS) for large Projects that will require international funding. PS4 which deals specifically with Community Health, Safety and Security, recognises that Project activities result in both positive and negative impacts to communities. The GPN has been developed specifically to provide guidance on community health for this Standard.

This approach will be supported by a systematic and consistent approach to collecting and analysing baseline health data through the Environmental Health Areas (EHA) framework. Twelve different EHAs are described, which provide a linkage between Project-related activities (crematorium) and potential positive or negative community-level impacts. This incorporates a variety of biomedical and key social determinants of health. Through this integrated analysis, environmental and social conditions that contain significant health components are identified instead of focusing primarily on disease-specific conditions.

Activities

The specific activities of the HIA[1] included:

- A desktop literature review outlining the host country and its community health profile;
- Collecting additional secondary information that was not available in the public domain that is available in published and grey data[2];
- Understanding the crematorium design, present and planned work activities, and location of PACs;
- Considering the potential human health impacts that the proposed development will have on the health of the respective communities;
- Determining the existing health needs of the community based on health strategies, infrastructure, programs, service priorities, delivery plans and challenges; and
- Developing evidence-based recommendations to avoid/mitigate negative and enhance positive impacts resulting from the proposed Crematorium development.

It is the specialist's opinion that due process has been followed. Where impacts have been assumed to be potentially significant, various mitigation measures to manage and monitor the impacts of the proposed development has been proposed. Adequate mitigation measures have been provided and are expected to reduce the significance of almost all negative impacts although not always to acceptable levels, while positive impacts will on average be significantly enhanced to maximise benefits to surrounding communities. The recommended mitigation measures must be implemented to minimise the impacts and ensuring compliance with current legislative requirements.

[1] It should be noted that the HIA is specific to the health impacts on communities and does not address any aspect of health and safety applicable to the workforce at the crematorium.

[2] Grey literature is a type of information or research output produced by organisations, outside of commercial or academic publishing and distribution channels. Common grey literature publication types include reports (annual, research, technical, project, etc.), working papers, government documents, and evaluations. Organisations that produce grey literature include government departments and agencies, civil society or non-governmental organisations, academic centres and departments, and private companies and consultants.

Key Findings and Recommendations

Air pollution is one of the major environmental risks to health. According to the Global Burden of Disease Study, air pollution is ranked among the top five out of 87 risk factors, competing with significant global health risks (GBD 2019 Risk Factors Collaborators, 2020). Deteriorating urban air quality has implications for human health, climate, the environment, and visibility. Some air pollutants, called criteria pollutants, are known to be hazardous to human health and wellbeing. The South African national ambient air quality standards (NAAQS) (Government Notice No. 1210, 2009; Government Notice No. 486, 2012) provide a basis for protecting public health from some of the adverse effects of these pollutants. These standards prescribe the maximum ambient concentrations permitted during a specified time period in a defined area. If the air quality standards are exceeded, there is an increased health risk. The criteria pollutants are PM2.5, PM10, SO2, NO2, O3, C6H6, Pb and CO.

Whilst there is little doubt that the cremation of human cadavers generates numerous harmful air pollutants, including particulate matter (PM), sulfur dioxide (SO2), nitrogen oxides (NOx), volatile organic compounds (VOCs), and heavy metals and that these pollutants may have adverse effects on the surrounding environment and human health, presently, the awareness of the emission levels of harmful air pollutants from crematoria and their emission characteristics is insufficient.

The major emissions from crematories are nitrogen oxides, carbon monoxide, sulphur dioxide, particulate matter, mercury, non-methane volatile organic compounds (NMVOCs), other heavy metals, and some POPs. The emission rates depend on the design of the crematory, combustion temperature, gas retention time, duct design, duct temperature and any control devices. Particulates such as dust, soot, ash and other unburned particles originate from the cremation container, human remains, and other contents of the container. Carbon-based organic particulates should be removed in the secondary combustion chamber and through proper adjustment and operation of the cremation equipment. Carbon monoxide results from the incomplete combustion of the container, human remains, fuel, and other contents. Carbon monoxide may be minimised through proper adjustment and operation of the cremation equipment.

Sulphur dioxide is produced from the combustion of fossil fuels, container, and contents. The sulphur content of natural gas and human remains is low, but other fuels may contain a significant portion of sulphur. Nitrogen oxides are formed by high temperature combustion processes through the reaction of the nitrogen in air with oxygen. Nitrogen oxide emissions from crematories are low and are not of major concern. Control of nitrogen oxides can be achieved through temperature control and burner design. Mercury emissions originate from the dental fillings that may contain 5 to 10 grams of mercury depending on the numbers and types used. Mercury may be removed through the use of selenium salt in the cremation chamber (Hogland W., 1994) or scrubbers. NMVOCs are produced from incomplete or inefficient combustion of hydrocarbons contained in the fuels, body, and casket. NMVOCs are reduced through the proper use and adjustment of the crematory.

Dioxins and furans result from the combustion of wood cellulose, chlorinated plastics, and the correct temperature range. Dioxins and furans may be reduced through reduction in the chlorinated plastics and with sufficiently high temperature and residence time in the secondary combustion chamber. Reformation of dioxins and furans can be avoided by good design of the flue-gas ducts, by reducing particulate deposition and avoiding the dioxin and furan reformation temperature window.

Most contaminants except for the heavy metals can be minimised through the proper operation of the crematory in conjunction with adequate temperature and residence time in the secondary combustion chamber. Sulphur oxide may be minimised through the use of low sulphur fuels such as natural gas. Heavy metals except for mercury may be removed through particulate control devices. Mercury can be removed by adding activated carbon to the particulate control devices e.g., bag filters.

Emissions may be further reduced through the use of different types of containers such as fibreboard and cloth-covered fibreboard instead of the traditional finished wood. Management and control measure of odour emissions and contaminants in crematorium may be reduced and / or eliminated through installation of ventilators and exhaust fans, considering practical conditions, such that low-concentration odour emissions can be promptly diluted and discharged. Furthermore, equipment will be operated in an intermittent working mode to reduce odour accumulation in the workshop associated with the workload.

Commonly used method for lowering odour emission levels is dilution. Dilution achieves odour reduction by passing the flue gas through a secondary combustion chamber, in which the odour generated in the main combustion chamber is burned again at a high temperature to generate CO, carbon dioxide, NOx, etc., while fresh air is blown through to dilute the odour. It is recommended that this method may be employed to further reduce odour at the crematorium.

Inhaling LPG vapor at high concentration even for a short time can cause asphyxiation, seizures, comas, heart problems and death. Inhalation of LPG may cause drowsiness or dizziness and respiratory irritation (cough, sneezing, headache, nose and throat pain). Exposure to high concentrations may cause breathing and heart problems, fitting, coma and death. Asphyxiation may also occur from exposure to high levels. 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 these impacts occurring, however, is improbable. The significance rating is therefore low, implying that the potential impact is 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 and human health. There is a high confidence associated with the impacts and the reversibility of the impacts is high.

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1. Introduction

Ikamva Green Holdings, trading as Platinum Pride, are in the process of obtaining the necessary permissions to commission a crematorium at 55 Stella Road in Montague Gardens, Cape Town. The crematorium is envisioned to be commissioned in two phases: Phase 1, which includes the installation of 2 cremators, and Phase 2, which includes the installation of an additional 4 cremators. Each cremator has the capacity to cremate 24 cadavers in a 24-hour period. This means that the crematorium, after commissioning Phases 1 and 2, will have a maximum cremation capacity of 144 cadavers per day.

Sharples Environmental Services cc (SES) has been appointed by Mr Sybrand Teubes of Ikamva Green Holdings, trading as Platinum Pride Crematorium, to undertake the environmental assessment, in accordance with the National Environmental Management Act, 1998 (Act 107 of 1998), in terms of the Environmental Impact Assessment Regulations, 2014 (as amended 2017). Sharples Environmental Services cc (hereafter, SES) on behalf of Ikamva Green Holdings, trading as Platinum Pride appointed Naira Environmental Consultants (Pty) Ltd to undertake a Rapid Appraisal Health Impact Assessment (HIA) for the proposed Platinum Pride Crematorium Project.

Risks to health posed by emissions of hazardous air pollutants from crematories are emerging concerns. The presence of silver–mercury amalgams in bodies results in airborne emissions of mercury; and the combustion of essentially any material results in emissions of polychlorinated dibenzodioxins and furans (PCDD/Fs; “dioxins”) (Green, 2013). This document presents the results of the Baseline Health Impact Assessment (HIA) for the above-mentioned Project. The objective of the overall Study is to assess the human health impacts associated with the proposed Crematorium Project on the population of concern, with particular reference to vulnerable people, through the evaluation of various determinants of health, including those identified in the various specialist studies. To ensure that environmental health becomes part of the Environmental Authorisation decision making process, health will need to be integrated into the present process in a structured and systematic manner. This will ensure that human health issues, resulting from a listed activity, are addressed before the start of an activity.

This HIA Report takes into consideration all the relevant background information (in this case, environmental and health information) including laws, demographics of the affected population, health status, project details, etc., providing a complete characterisation of the current situation around the Project.

2. Terms of Reference

As the site is within 500m of a habitable dwelling (Milnerton Fire Station), The Department of Environmental Affairs and Development Planning (DEA&DP) have requested we get input in the form of a Health Impact Assessment. During the public consultation period, it was confirmed that the fire station is zoned as a utility zone and does not appear to be residentially zoned, so there should not be residential dwellings.

A 'desktop' HIA draws on existing knowledge and evidence, often using published checklists which provide a broad overview of potential health impacts. A 'rapid' assessment, is a more resource intensive process, involving a more focused investigation of health impacts and recommending mitigation and enhancement measures. Lastly, a comprehensive or 'full' HIA involves comprehensive analysis of all potential health and wellbeing impacts, which may include quantitative and qualitative information, data from health needs assessments, reviews of the evidence base and community engagement. The scope for this component was a Rapid Appraisal HIA.

A Rapid HIA was thus conducted as a specialist study for the compilation of the Basic Assessment (BA) in support of the Environmental Authorisation for the proposed Project. This study baseline component of the study evaluated the different types of evidence from readily available information, in order to assess the health impacts associated with the Project on the population of concern. In so doing, the project aimed to adhere to the relevant provisions contained in the Equator Principles (IFC, 2006). These provisions had been derived from the principles themselves and the International Finance Corporation (IFC)'s Performance Standards and Environmental Health and Safety (EHS) Guidelines.

Health is gaining prominence in public policies in accordance with its importance as a core value for population wellbeing and thus, as a driving force for sustainable human and social development. The assessment and management of community health is part of risk management and social responsibility of an operator.

The Terms of Reference for the HIA comprised the following:

- A desktop review in order to outline the country and community health profile and to determine any data gaps;
- Review of other specialist studies conducted as part of the BA to identify significant impacts that may have health implications e.g., Air Quality Impact Assessment.
- An impact assessment process which involved:
  - Considering the potential future health impacts that the proposed project will have on the health of the respective communities; and
  - Considering recommendations for mitigation/management of priority impacts. Recommend measures to avoid/mitigate negative and enhance positive impacts resulting from the project at the relevant project stage.

As mentioned above, the Platinum Pride Crematorium is envisioned to be commissioned in two phases: Phase 1, which includes the installation of 2 cremators, and Phase 2, which includes the installation of an additional 4 cremators. Each cremator has the capacity to cremate 24 cadavers in a 24-hour period. Thus, in total, the site will have the capacity to cremate 48 cadavers per day during Phase 1. Phase 2 will consist of the installation of an additional four cremators, also operating 24 hours per day. After the completion of phase 2, the site will have the capacity to cremate 144 cadavers per day. This Report is based has considered this and, although unlikely, assumes "worst-case scenario" of 144 cadavers per day.

3. Aims and Objectives

The over-riding objective of a HIA is to maximise health gain and reduce health inequalities. Another predominant aim of the HIA is to provide decision-makers with a set of recommendations on health issues associated with the Project, so that health objectives may be considered at the same level as socio-economic and environmental objectives.

The objectives are:

- To predict the likely impacts the project may have on the health of any surrounding communities; and
- To formulate mitigation measures to avoid or ameliorate negative community health impacts and to enhance positive ones.

This was achieved through:

- Evaluating various determinants of health, including those identified in the Air Quality Impact Assessment;
- Reviewing and assessing comments as received during the stakeholder engagement process; and
- Desktop and literature reviews -this baseline assessment.

4. Details and Expertise of Specialist

Vumile Ribeiro is currently the Director of Environmental Management Services at Niara Environmental Consultants (Pty) Ltd. Vumile has 15 years of professional experience in Environmental Assessment and Management. Her roles include the executive management responsibilities of Niara Environmental Consultants, project management, client and business development, marketing and quality assurance as well as corporate compliance. Having worked for a multi-disciplinary advisory firms and environmental consultancies, Vumile has a competent understanding of the work effort and cross collaboration required for a successful multidisciplinary organisation. Vumile has been involved in a number of Environmental Impact Assessments and has a particular interest in health impacts assessments, water resource management, mining, energy and stakeholder engagement. Vumile has considerable experience across a range of developmental and environmental sciences and has worked in South Africa, Mozambique, Sierra Leone and Liberia and is familiar with Regulatory Environmental Legislation in other parts of Africa.

Vumile is very well versed in the IFC Environmental and Social Performance Standards (including IFC PS 2012) and the associated Equator Principles, which have informed the approach and standard for a number of ESIA processes that she has been involved in. Vumile is skilled at organising and driving effective project teams at a scale relevant to the project's requirements. She has technical experience and is able to quickly identify the most

pertinent issues of a particular project whilst focussing on driving project success by rigorously implementing project management tools.

Vumile has experience ranging over several aspects of social research, including the planning and execution of social surveys, participatory rural appraisal, sustainable livelihoods assessments, data management and statistical analysis, capturing and management of spatial data, stakeholder identification and community facilitation. She has acted as project manager and/or task leader on a number of social impact studies in Africa. Social impact studies included both mining development and linear projects.

A comprehensive Curriculum Vitae (CV) of the specialist has been attached as Appendix A.

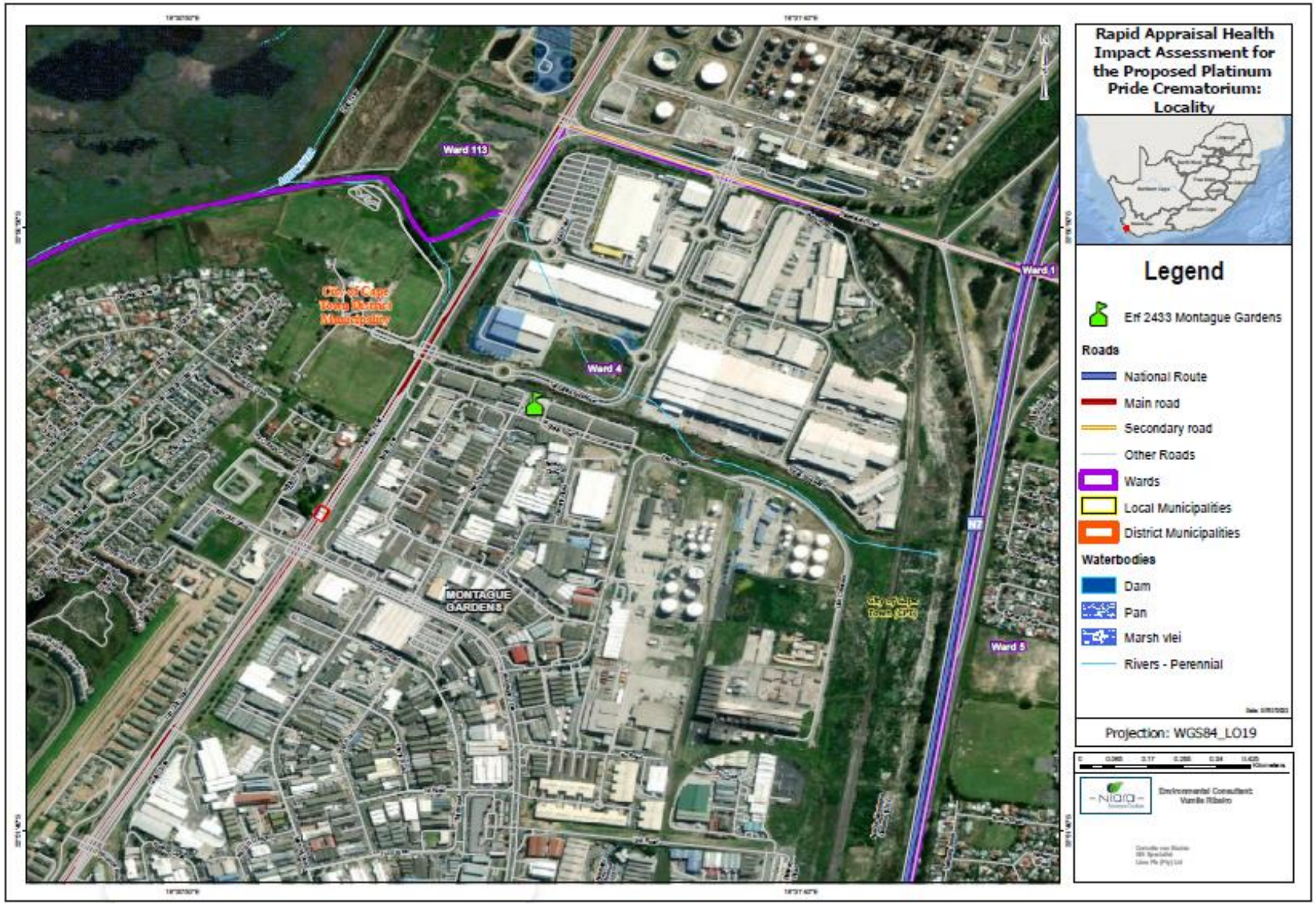


Figure 4-1: Local Setting

5. Project Description

The proposed development site is situated in Montague Gardens Industrial Area, Ward 4, on ERF 2433. The site is approximately 2 506.7m2 in size, and is zoned as General Industrial Zone I, which does accommodate crematorium facilities. The site contains existing infrastructure, is fenced and has been transformed significantly, resulting in the majority of the site containing concrete or tar surfaces. A small area to the rear (north) of the site, has not been transformed into a hardened surface. This area is approximately 481m^2, and is predominantly sandy with sporadic vegetation, including alien invasive tree species. This area is disturbed and contains building waste and stormwater infrastructure. The site is currently being utilized by Crous Chemicals cc., an organization that manufactures numerous chemical products for a variety of industries.

The establishment of a crematorium at the site is to take place in two phases:

- Phase 1 will consist of the installation of two cremators that operate 24 hours per day. Each cremator has a maximum cremation capacity of 24 cadavers per day. Thus, in total, the site will have the capacity to cremate 48 cadavers per day.
- Phase 2 will consist of the installation of an additional four cremators, also operating 24 hours per day. After the completion of phase 2, the site will have the capacity to cremate 144 cadavers per day.

The proposed scope of works includes the renovations of the existing warehouse facility as follows:

- Installation of 6 x BA2 cremators (manufactured by Engineered Thermal Systems) and associated infrastructure
- LPG tanks (fuel source for cremators), stored on site in excess of 80m3, but less than 500m3
- 6 x Chimney stacks approximately 0.35m in diameter, and approximately 6m's above the nearest building
- 3 x reefer coolers and one cool room
- Each reefer can take 60 units, in total with three reefers and one cool room, for stockpiling purposes, where necessary
- Associated infrastructure and services
- Safety Plans:
    - Compilation of a fire plan and equipment, safety measures;
- Modifications to the inside of the building includes
    - Resurfacing including flooring
    - New offices
    - Sterilization of the interior
    - Servicing of roll-up doors
- Modifications outside include:
    - New ABR sheets will be utilized on the outside

- Painting
- Appropriate signage

Johnson Thermal Engineering are the designers of the JTE BA1 and BA2 Cremator Machines, locally manufactured and distributed in South Africa by Engineered Thermal Systems (PTY) Ltd who have a proven track record of successful operation that meets the Air Emission requirements for new plants as specified by the National Environmental Management: Air Quality Act (NEM: AQA). Their Our design, manufacture, testing and commissioning is done in accordance with SANS329 (Industrial Thermo-Processing Equipment) and it conforms to SANS347 (Categorization and conformity assessment Criteria for all Pressure Equipment). The JTE BA2 Cremator Machines are designed as a starved combustion or sub stoichiometric primary chamber cremator, that ensures the gas velocities are reduced, resulting in lower particulate pickup.

Their JTE BA2 Cremator Machines are configured to only start the cremation process if the secondary chamber is above 600°C in temperature. This ensures that during the cremation process the secondary chamber temperature will rapidly rise to control at 850°C or higher to result in complete combustion of the gases and odours before existing the cremator stack. The secondary chamber of the JTE BA2 Cremator Machines are designed with sufficient volume to provide 2 seconds of high temperature exhaust gas residence time, to ensure low carbon monoxide emission and total combustion of complex volatile organic compounds.

Their JTE BA2 Cremator Machines are equipped with an ejector in base of the cremator stack to aid with the drafting of the cremator to maintain a slight negative pressure within the primary chamber, to ensure that no gases or noxious fumes are emitted into the cremator machine room when the door is opened.

As per the details supplied on the technology, this machinery is expected to significantly reduce emissions and in turn reduce any health impact to the surrounding community which may occur due to the proposed Platinum Pride Crematorium Project.

6. South African Legislation Pertaining to Health

6.1 Constitution of the Republic of South Africa (Act 108 of 1996)

The over-arching legislation is the Constitution of South Africa (Act 108 of 1996) (the Constitution), in particular Section 24, which places people and their needs at the forefront of environmental management. The Constitution provides a right to “an environment that is not harmful to [human] health or well-being” and to have the environment protected, for the benefit of present and future generations, through reasonable legislative measures. These measures include the prevention of pollution and ecological degradation, the promotion of conservation, the securing of ecologically sustainable development and the utilisation of natural resources while promoting justifiable economic and social development.

6.2 The National Health Act (Act 61 of 2003)

The National Health Act, 2003 (Act No. 61 of 2003) (NHA) provides a framework for a structured uniform health system in South Africa, considering the obligations with regard to health services imposed on the national, provincial and local governments by the Constitution and other laws. Any activity that gives rise to offensive/injurious conditions or is dangerous to health (e.g., accumulation of refuse) may have a negative impact on health and thus warrants being assessed in the EHIA (DOH, 2010). The Director General (DG) should issue and promote adherence to, norms and standards on health matters, including conditions that constitute a health hazard and facilitate the provision of indoor and outdoor environmental pollution control services. The Act also provides for environmental health investigations in Section 88.

Additionally, in terms of the National Health Act, 2003 (Act No 61 of 2003), Regulations Relating to the Management of Human Remains, May 2013, Chapter 6, point 18 – Minimum requirements for a cremation facility. The proposal implemented as planned will ensure that the crematorium is compliant with points 18(1) (b - g). In terms of point 18(1)(a), "the site must be located at least 500m from any habitable dwelling…"

6.2.1 Regulations Relating to the Management of Human Remains, 2013

In terms of Section 68(1)(b) and 90(4)(c) of the NHA which govern preservation, use and disposal of bodies, the Regulations Relating to the Management of Human Remains (GN No. R. 363 of 2013) was promulgated. Of applicability to the proposed development, Regulation 18 provides: Minimum requirements for a cremation facility:

(a) The site must be located at least 500m from any habitable dwelling;

(b) The chimney must have a height of not less than 3 meters above the roof;

(c) No cremation shall take place until the minimum combustion temperatures of the urn has been reached;

(d) The premises shall be kept in a clean, sanitary and in good repair;

(e) The facility shall be adequately ventilated and illuminated;

(f) The facility shall be operated and managed in a manner as to prevent the dispersion of ash into the atmosphere; and

(g) Emissions levels shall conform to the ambient air quality emission standards as determined in terms of the National Environmental Management: Air Quality Act of 2004.

In the case of the Platinum Pride Crematorium Project, the surrounding land uses and zoning support industrial, commercial, utilities and business zones. The proposed Crematorium is not located within 500m radius of any zoned residential area, however, the Atmospheric Impact Assessment compiled by Yellow Tree (2022) advises

that the Milnerton residential area is located 300 metres to the east of the proposed site and that the Milnerton Fire Station and Traffic Department is within 500m radius, with infrastructure similar to housing located to the north-west of the fire station. It has, however, decided during the public consultation period, it was confirmed that the fire station is zoned as a utility zone and does not appear to be residentially zoned, so there should not be residential dwellings.

Section 17: Issuance of a cremation permit.

- All cremations shall be permitted by the relevant local government.
- (2) A local government may not issue a cremation permit; unless the application is accompanied by a declaration by the medical officer who declared the deceased dead, (and if applicable, who also performed post mortem examination of the deceased) whom cremation is intended, indicating causes of death whether is natural or from any dreadful communicable disease, and that the remains of the deceased may be disposed.

6.3 National Environmental Management: Air Quality Act 39 of 2004

Air quality in South Africa is governed under the NEM: AQA. The main objective of the Act is to ensure the protection of the environment and human health through reasonable measures of air pollution control within the sustainable economic, social, and ecological development framework.

Various activities have been identified that, due to their processes, may result in air pollution that is detrimental to health and the environment. In terms of Section 21 of the NEM: AQA, a list of these activities was first published in 2010 (Government Notice No. 248, 2010).It was repealed in 2013 (Government Notice No. 893, 2013), and the 2013 list was amended in 2015 (Government Notice No. 551, 2015), 2018 (Government Notice No. 1207, 2018), 2019 (Government Notice No. 687, 2019) and 2020 (Government Notice No. 421, 2020). This legislation specifies minimum emission standards (the permissible amount, volume, emission rate or concentration that may be emitted) in respect of substances or a mixture of substances resulting from a listed activity. It also specifies the manner in which measurements of such emissions must be carried out. All listed activities must obtain an atmospheric emissions licence (AEL) in order to operate. The issuing of AELs is the responsibility of the metropolitan and district municipalities; however, the province may be delegated this responsibility. A provincial Air Quality Officer (AQO) is required to be appointed who will be responsible for coordinating air quality management requirements and the issuing of AELs (if a Metro/District has delegated its function to the Provincial Organ of the State in terms Section 238 of the Constitution; whenever a licensing authority fails to take a decision on an application for an atmospheric emission licence; and if a municipality applies for an atmospheric emission licence.)

The NEM: AQA also shifted some of the approach of air quality management from source-based control to receptor-based control. With receptor-based control the ambient air quality of receptors is the factor which is used

to determine the compliance of the emission source. The measured, or expected, ambient air quality of receptors is compared to National Ambient Air Quality Standards (NAAQS). These standards prescribe the maximum ambient concentrations of pollutants permitted (and the number of exceedances allowed) during a specified time period in a defined area. If the air quality standards are exceeded, the ambient air quality is poor and the potential for health effects is greatest. The NAAQS, therefore, provide a basis for protecting public health from adverse effects of air pollution and for eliminating, or reducing to a minimum, those contaminants of air that are known, or likely, to be hazardous to human health and wellbeing (WHO, 2000). The South African NAAQS for criteria pollutants were published in 2009 (Government Notice No. 1210, 2009) in terms of Section 9(1) of the NEM: AQA. The criteria pollutants include benzene (C_6H_6), carbon monoxide (CO), lead (Pb), nitrogen dioxide (NO_2), particulate matter with an aerodynamic diameter of less than 10 µm (PM_{10}), ozone (O_3) and sulphur dioxide (SO_2). In 2012, particulate matter with an aerodynamic diameter of less than 2.5 µm ($PM_{2.5}$) was also promulgated as a criteria pollutant (Government Notice No. 486, 2012). Provincial government may introduce more stringent Air Quality Standards than the NAAQS, and similarly, local government may introduce more stringent Air Quality Standards than the Provincial Air Quality Standards.

Table 6-1: National Ambient Air Quality Standards for Criteria Pollutants (Government Notice No. 1210, 2009; Government Notice No. 486, 2012)

Pollutant	Averaging Period	Concentration (µg/m³)	Concentration (ppb)
SO_2	10-minute running average	500	191
	1-hr average	350	134
	24-hr average	125	48
	Annual average	50	19
NO_2	1-hr average	200	106
	Annual average	40	21
CO	1-hr average	30	26
	8-hourly running average	10	8.7
O_3	8-hourly running average	120	61
PM_{10}	24-hr average	75	-
	Annual average	40	-
$PM_{2.5}$	24-hr average	40	-
	Annual average	20	-
Pb	Annual average	0.5	-
C_6H_6	Annual average	5	1.6

The NEM: AQA provides for additional measures to be implemented, including the declaration of controlled emitters (Sections 23 to 25), controlled fuels (Sections 26 to 28), priority air pollutants (Section 29), and measures for dust,

noise and offensive odours (Section 32, 34, and 35, respectively). Regulations for controlled emitters have been established for small boilers (Government Notice No. 831, 2013), temporary asphalt plants (Government Notice No. 201, 2014) and small-scale char and charcoal plants (Government Notice No. 602, 2015). No regulations for controlled fuels have been legislated to date. Greenhouse Gases were legislated as priority air pollutants in 2017 (Government Notice No. 710, 2017). Any industries or industrial sectors that emit these priority pollutants are required to implement a Pollution Prevention Plan (Government Notice No. 712, 2017).

The National Dust Control Regulations of 2018 (Government Notice No. 517, 2018) have been developed as a measure for dust, applicable to all entities nationwide. The 2017 NFAQM has listed provincial government as having principal responsibility, together with metropolitan and district municipalities, for monitoring compliance with the requirements of the National Dust Control Regulations for listed activities.

Table 6-2: Acceptable dustfall rates (Government Notice No. 517, 2018)

Restriction Areas	Dustfall Rate (D) (mg/m²/day) (30-day average)	Permitted Frequency of Exceeding Dustfall Rate
Residential Areas	D < 600	Two within a year, not sequential months.
Non-Residential Areas	600 < D < 1,200	Two within a year, not sequential months.

The standard test method to be used for measuring dustfall rate and the guideline for locating sampling points shall be ASTM D1739. The latest version of this method shall be used.

6.4 National Ambient Air Quality Standards

The Department of Environmental Affairs (DEA) issued ambient air quality guidelines for several criteria pollutants, including particulates, sulfur dioxide, oxides of nitrogen, lead, ozone and carbon monoxide. The National Environmental Management: Air Quality Act, 2004 (Act No. 39 of 2004) (NEM: AQA) adopted these guidelines as National Ambient Air Quality Standards (NAAQS). On 2 June 2006, the Minister of Environmental Affairs and Tourism announced his intention of setting new ambient air quality standards in terms of Section 9(1)(a) and (b) of the NEM: AQA. The proposed new standards were published for public comment in the Government Gazette of 9 June 2006. Since then, updated draft National standards with allowable frequencies of exceedance and compliance timeframes have been proposed.

The prevailing legislation in the Republic of South Africa with regards to air quality is the NEM: AQA. The NEM: AQA serves to repeal the Atmospheric Pollution Prevention Act (Act no. 45 of 1965) (APPA).

The purpose of NEM: AQA is to set norms and standards that relate to:

- Institutional frameworks, roles and responsibilities;
- Air quality management planning;
- Air quality monitoring and information management;

- Air quality management measures; and
- General compliance and enforcement.

Guidelines provide a basis for protecting public health from adverse effects of air pollution and for eliminating, or reducing to a minimum, those contaminants of air that are known or likely to be hazardous to human health and well-being (WHO, 2000). Once the guidelines are adopted as standards, they become legally enforceable. These standards prescribe the allowable ambient concentrations of pollutants which are not to be exceeded during a specified time period in a defined area. If the air quality guidelines/standards are exceeded, the ambient air quality is poor and the potential for health effects is greatest.

Air quality legislation comprises primary standards which protect human health and secondary standards which protect property, vegetation, climate and aesthetic values. The development of new industries that increase air pollution through the emission of gases in the atmosphere should be managed.

6.5 National Environmental Management Act, 1998 (Act No. 107 of 1998), as amended

The National Environmental Management Act (NEMA) provides the legislative framework for Integrated Environmental Management (IEM) in South Africa. Section 24 provides that all activities that may significantly affect the environment and require authorisation by law must be assessed prior to approval. NEMA also provides for co-operative environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance and procedures for co-ordinating environmental functions exercised by organs of the State and to provide for matters connected therewith. Section 2 of NEMA establishes a set of principles that apply to the activities of all organs of state that may significantly affect the environment.

These include the following:

- Development must be sustainable;
- Pollution must be avoided or minimised and remedied;
- Waste must be avoided or minimised, reused or recycled;
- Negative impacts must be minimised; and
- Responsibility for the environmental health and safety consequences of a policy, project, product or service exists throughout its life cycle.

These principles are taken into consideration when a government department exercises its powers, for example during the granting of permits and the enforcement of existing legislation or conditions of approval.

Section 28(1) of NEMA states that “every person who causes, has caused or may cause significant pollution or degradation of the environment must take reasonable measures to prevent such pollution or degradation from

occurring, continuing or recurring". If such pollution cannot be prevented, then appropriate measures must be taken to minimise or rectify such pollution. These measures may include:

- Assessing the impact on the environment;
- Informing and educating employees about the environmental risks of their work and ways of minimising these risks;
- Ceasing, modifying or controlling actions which cause pollution/degradation;
- Containing pollutants or preventing movement of pollutants;
- Eliminating the source of pollution; and
- Remedying the impacts of the pollution.

The authorities may direct an industry to rectify or remedy a potential or actual pollution problem. If such a directive is not complied with, the authorities may undertake the work and recover the costs from the responsible industry.

6.6 Other Relevant Legislation

Acts and Regulations pertaining to health and environmental, and health in particular, are indicated in Table 6-1.

Table 6-3: Acts and Regulations relevant to Health and Environmental Health

National legislation	Relevance to HIA
Atmospheric Pollution Prevention Act (Act 45 of 1965)	Hazardous substances associated with air pollution affect human health. This Act has identified some of the activities for which authorization for emissions is required from the DEA (DOH, 2010).
National Water Act (Act 36 of 1998)	The quality of water in domestic water sources impacts on human health. The Act provides for the protection of water quality for the benefit of human health and aquatic ecosystems through the concept of the reserve determination process (DOH, 2010).
Water Services Act (No. 108 of 1998)	Water services (water supply services and sanitation services) may impact on human health. Water service providers have an important role to play in this regard. Proposed activities may involve industrial use of water, which is covered under Section 7 of this Act (DOH, 2010)

6.7 International Management Standards

There are a number of international guidelines or best practice guidelines that refer to community health in development or industrial Projects. The World Bank Group's standards and norms, in particular those developed

by its private sector arm, the International Finance Corporation (IFC), are generally considered as the benchmark. The IFC has published a set of Performance Standards for large projects that will require international funding. Performance Standard 4 (PS4): Community Health, Safety and Security, recognises that Project activities result in both positive and negative impacts to communities (IFC, 2012). The objectives of this PS4 are:

- To avoid or minimise risks to and impacts on the health and safety of the local community during the Project life cycle from both routine and non-routine circumstances; and
- To ensure that the safeguarding of personnel and property is carried out in a legitimate manner that avoids or minimises risks to the community's safety and security.

IFC Performance Standard 4 "Community Health, Safety and Security" states that:

"The client will evaluate the risks and impacts to the health and safety of the Affected Communities during Project life-cycle and will establish preventive and control measures consistent with Good International Industry Practice (GIIP), such as in the World Bank Group Environmental, Health and Safety Guidelines (EHS Guidelines) or other internationally recognised sources. The client will identify risks and impacts and propose mitigation measures that are commensurate with their nature and magnitude. These measures will favour the prevention or avoidance of risks and impacts over minimization."

In addition to being considered the benchmark standards for major projects, the IFC's Performance Standards are applicable to projects seeking financing from either the IFC or other Equator Principles funding institutions.

Key requirements include:

- Evaluation of the risks and impacts of the affected community during the design, construction, operation and decommissioning of the Project;
- Where the Project poses risks to the health, safety and security of communities, an Action Plan will be disclosed on an on-going basis to enable the community to understand the risks and adverse impacts;
- The design, construction, operation and decommissioning of the Project will be in accordance with good international industry practice. Particular consideration will be given to potential exposure to natural hazards;
- Adverse impacts on soil and groundwater as a result of the proposed Crematorium Project will also be avoided;
- The transmission of communicable diseases from temporary or permanent labour will be minimised;
- Risks and impacts from Project activities will be assessed and communicated in a culturally-appropriate manner. Emergency community situations shall be addressed; and
- Where employees or contractors are retained to provide security, the risks to those inside and outside the Project site will be assessed.

7. Health Impact Assessment Framework and Methodology

It is important that a distinction is made between HIA and Health Risk Assessment (HRA). HRA is concerned with the identification of hazards and risks to the workforce which relate to occupational health and safety and engineering design. Generally, HRA is "within the fence" while HIA is "outside the fence" but there are distinct overlaps with HIA often taking a central position as workplace activities can affect community health and existing community health needs or disease burdens can affect workplace health. HIA is used to evaluate the public health consequences of proposed decisions in non-health sectors (CDC), while HRA is about "quantitative, analytic process to estimate the nature and risk of adverse human health effects associated with exposure to specific chemical contaminants or other hazards in the environment, now or in the future (CDC). Results from HRA can be used within a HIA to predict human health effects of specific exposures. It is thus important that these assessments should not be placed into individual elements but integrated to support an overall strategic plan for the Project. Workplace health is specifically out of scope of the HIA; however, it is important to understand which activities in the workplace can impact community health. This is important as the project activities can impart direct external influences on community health and the workforce also originates from the community and thus workplace activities and potential exposures must not be transferred back to the community at the end of shifts.

Due to the comments and concerns raised during the public review period of the proposed Project, high-level potential health impacts on both the public as well as crematorium workers has been assessed and discussed in this Report.

7.1 Environmental Health Areas

A World Bank analysis demonstrated that an almost 50% improvement in major health outcomes could be achieved by improvements in four sectors: (i) housing and urban development; (ii) water, food and sanitation; (iii) transportation; and (iv) communication. Building upon this sectoral analysis and incorporating a broad perspective on "environmental health" led to the development of a defined set of environmental health areas which have been adopted in the IFC Notes for PS4 the 2005 IPIECA (International Petroleum Industry Environmental Conservation Association) HIA guidelines and the IFC HIA GPN.

The IFC methodology uses twelve (12) Environmental Health Areas (EHAs) to support the systematic analysis of health considerations. These are summarized in

Table 7-2. The set of EHAs provides a linkage between project-related activities and potential positive or negative community-level impacts and incorporate a variety of biomedical and key social determinants of health. In this integrated analysis, cross-cutting environmental and social conditions that contain significant health components are identified instead of a HIA focusing primarily on disease-specific considerations – as is frequently done in many biomedical analyses of potential project-related public health impacts. The EHA framework is based on an analysis performed and published by the World Bank.

7.2 Potentially Affected Communities

To identify and quantify potential health impacts an accurate population profile is required and it is important to distinguish between differences in exposure and susceptibility. Thus, besides a demographic profile of the at-risk population and the identification of the most vulnerable groups, it is crucial to understand how the development, construction and operational activities are likely to impact at both a household and community level.

The key aspects when considering the potential influence of the project to the Potentially Affected Communities (PACs) is the exposure pathway of the potential health determinant. The following key elements need to be considered:

- Whether there is a hazard;
- Who or what may be exposed to this hazard (pathway and rate of exposure to estimate the concentration/extent to which human receptors of concern may be exposed);
- The mode (air, water, food, vector, social determinants etc.) and route (inhalation, ingestion etc.) of exposure;
- The risk of exposure based on a likelihood and consequence analysis (magnitude, duration and length); and
- How sensitive or vulnerable the receptor is to the potential hazard or impact.

As part of the analysis, the relevant overall population is stratified into PACs. A PAC is a defined community within a clear geographical boundary where project-related health impacts may reasonably be expected to occur. PACs are inherently prospective and simply represent best professional judgments. PACs are likely to change over the course of project implementation; and there may be changes in the project design, and thus its longer-term implications are not fully known. This implies that the definition of PACs may need further adaptation as the project moves ahead; therefore, the specification of a PAC should be viewed as time-dependent as it will evolve over the project cycle. Findings of social and economic assessments, resettlement plans and migration management plans need to be carefully updated as this allows linkage between the PACs and key demographic determinants such as age structure and population numbers.

Mitigation strategies may also require specific considerations for the different PACs. On the one hand, not all the EHAs may be of concern for mitigation for the individual PACs. On the other hand, a separate risk analysis for a

PAC may be indicated due to a particular susceptibility to a specific health impact. However, this scope of the impact assessment only limited risk analysis were carried out.

7.3 Introduction and Definition

A HIA is a practical, multi-disciplinary process, combining a range of qualitative and quantitative evidence in a decision-making framework. A HIA seeks to identify and estimate the lasting or significant changes of different actions on the health status of a defined population (Winkler *et al*., 2010). A HIA may be defined as "*a combination of procedures, methods and tools by which a Project may be judged as to its potential effects on the health of a population, and the distribution of those effects within the population*". The objective of a HIA is to deliver evidence-based recommendations to maximize potential positive health benefits and prevent or mitigate any detrimental health impacts that a Project may have on the potentially affected communities (PAC) (WHO/ECHP, 1999).

The WHO defines health as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity. This is influenced through complex interaction of social, economic, genetic, and environmental factors (WHO, 2010c). The ultimate deliverable of a HIA is a Community Health Management Plan (CHMP) (Winkler *et al*., 2011). This plan would be based on evidence and stakeholder input, prioritised according to impacts and needs and having clear indicators to monitor and evaluate impacts and programs.

The holistic model of health used in the HIA process acknowledges that the health status of a population is affected by factors known as health determinants (e.g., education, income level, health services, etc.). All of these are closely interlinked and differentials in their distribution lead to health inequalities. These include both biophysical and social determinants of health as well and not just purely health outcomes. The methodology allows HIA practitioners to consider how a Project affects these determinants of health, as well as health outcomes.

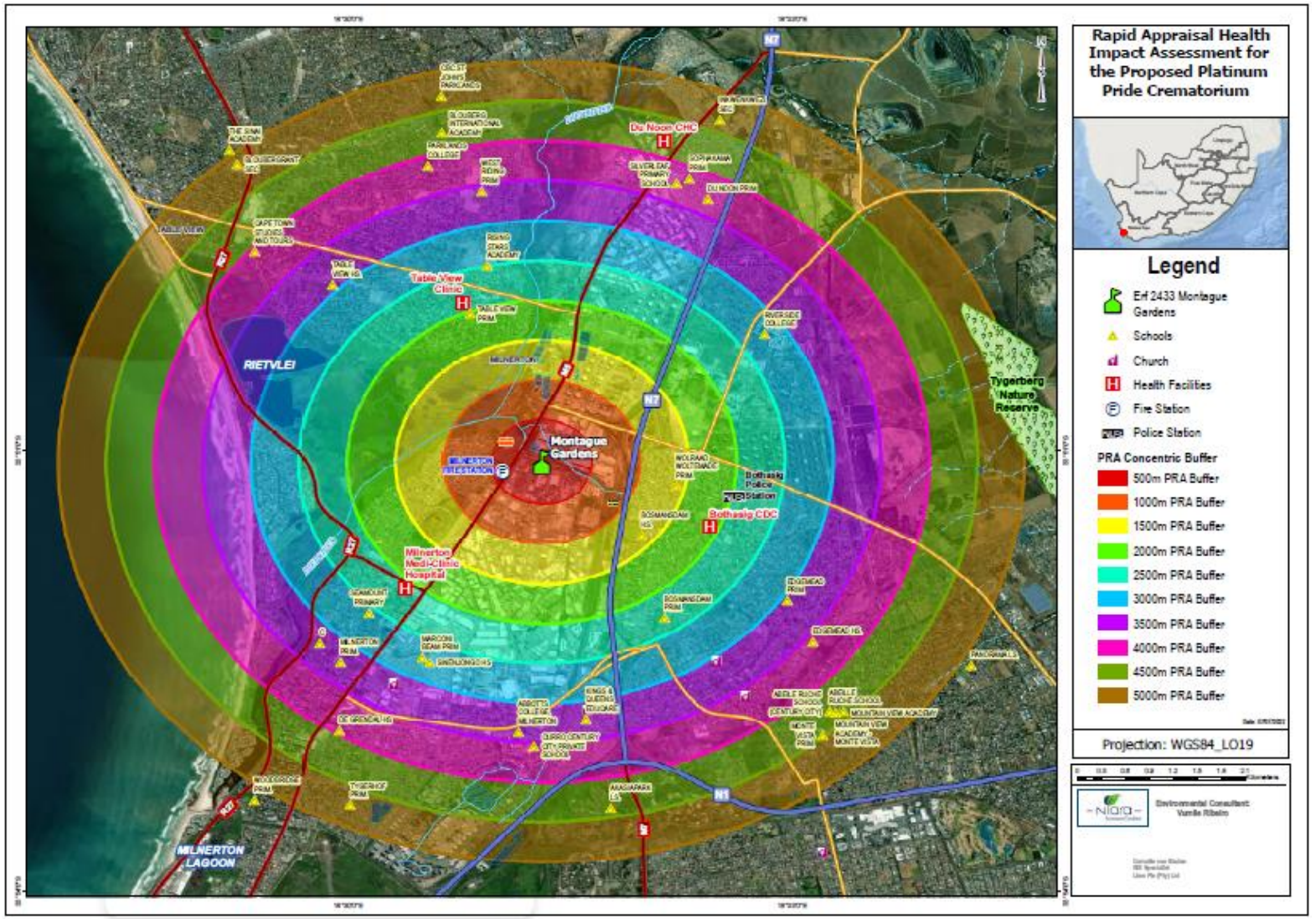


Figure 7-1: Identified Potentially Affected Communities

7.4 Determinants of Health

The driving concept behind HIA is that individual and community health is not simply determined by health services or biological factors (e.g., age). It is also shaped by wider social, economic and environmental influences and factors. These health determinants are the factors that lead to health outcomes and include:

- Physical environment factors (e.g., air quality, water quality, hazards)
- Built environment factors (e.g., buildings, public spaces, roads, bike lanes)
- Livelihood factors (e.g., income, employment)
- Social and community factors (e.g., social support, family structure, access to services)
- Lifestyle factors (e.g., diet, exercise, alcohol and tobacco use)

On the other hand, there are health-related outcomes. These health outcomes refer to the health status of both individuals and groups within a population or community, and can include both positive and negative outcomes. The health determinants—as impacted by an activity—contribute to health outcomes in various ways, either directly or indirectly. Health outcomes can include things like morbidity rates (injuries), mortalities, asthma, diabetes, cardiovascular disease, and other diseases. This Report uses a broader definition of health outcomes that includes the behaviours and contributing factors that contribute to an individual or community's health status. The process diagram (Figure 7-2) illustrates the general relationship between an activity, the impacts activities can have on health determinants, and the resulting influences and changes to health-related outcomes. These determinants of health encompass all 12 EHAs.

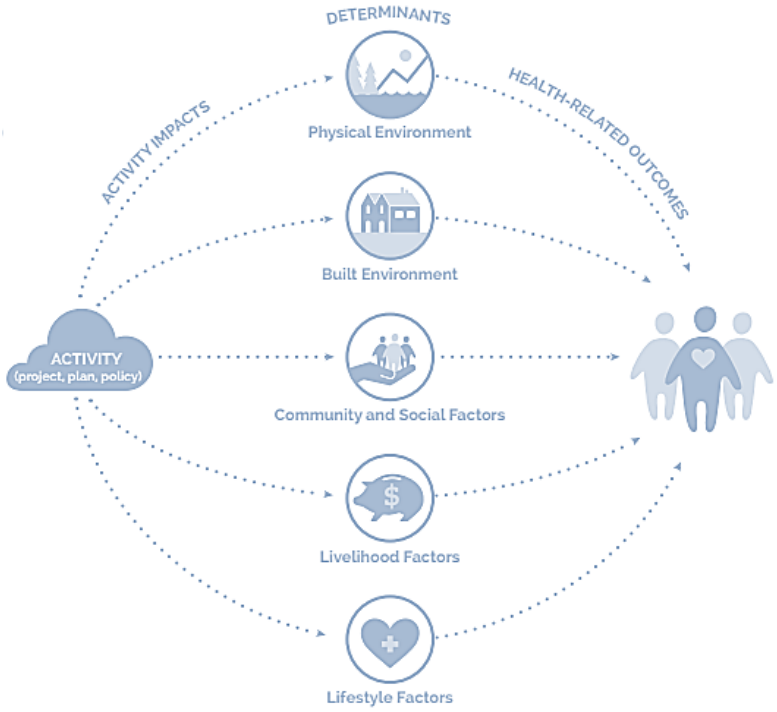


Figure 7-2: Activity impacts, health determinants and health-related outcomes

7.5 Overview of the HIA Process

A standardised approach was considered for the HIA to ensure that evidence-based recommendations supported the impact assessment. To ensure compliance with the IFC performance standards, and especially PS4, the methodology outlined in the Good Practice Note for HIA from the IFC, was adopted (IFC, 2009). The main elements of this are illustrated in Figure 7-3. These are also discussed briefly below so that the context of the HIA is understood.

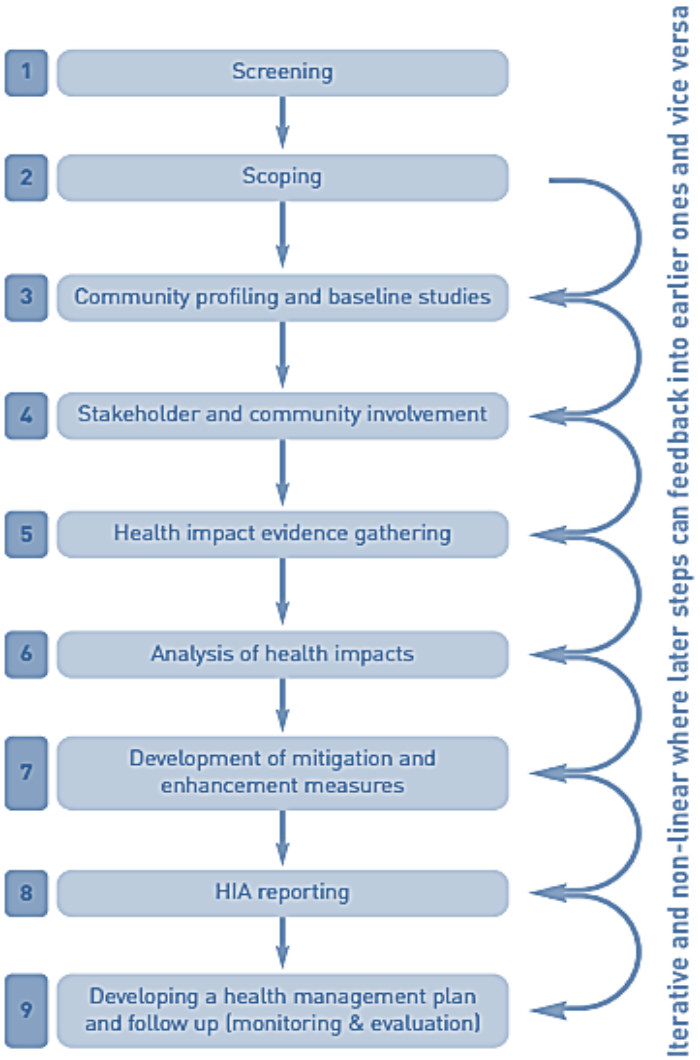


Figure 7-3: HIA Procedure

The framework that is commonly used for a HIA follows a 6-step process (IFC, 2009):

- Screening (preliminary evaluation to determine the necessity of a HIA);
- Scoping (identifying the range of potential Project-related health impacts and defining the terms of reference for the HIA, based on published literature, local data and broad stakeholder consultation and how these may be influenced by the Project);

- Risk assessment (qualitative and quantitative appraisal of the potential health impacts in relation to defined communities and the Project development, including stakeholder participation);
- Appraisal and mitigation (development of a CHMP) based on the findings of the risk assessment);
- Implementation and monitoring (realisation of the CHMP including monitoring activities that allow for adaptation); and
- Evaluation and verification of performance and effectiveness (key step to analyse the HIA process as a whole).

This HIA aims to influence design and inform the construction, operation and decommissioning phases of the Project. As HIAs are dynamic iterative processes they do require flexibility in their methodologies and tools, so that they can be fit for purpose for different Projects.

Figure 7-4 shows a decision-flow diagram outlining the decision steps, and the key questions to consider, from screening to a rapid in-house HIA and onto a more formal rapid or in-depth HIA.

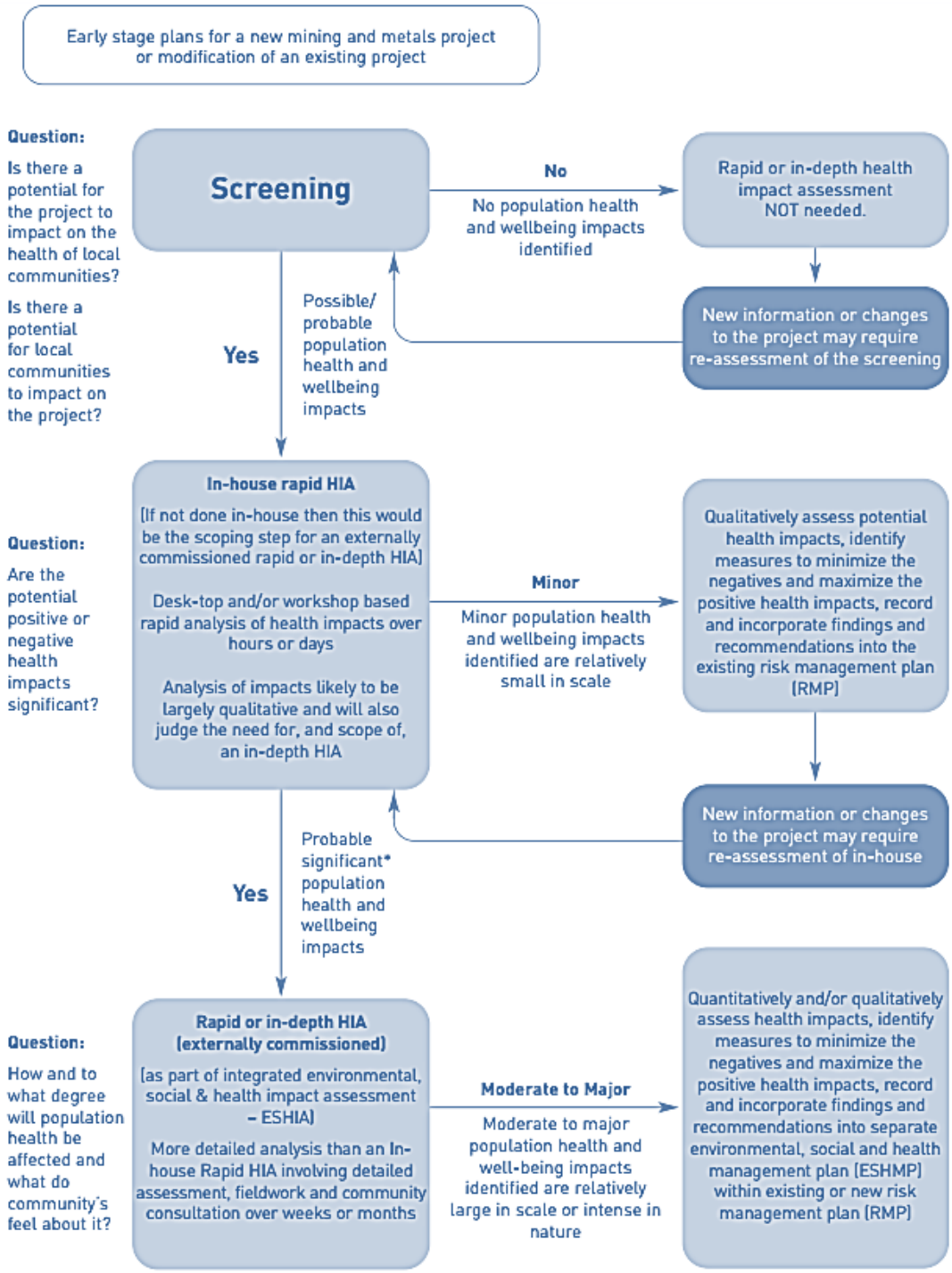


Figure 7-4: Decision tree for Health Impact Assessment

7.6 Benefits of HIA

Assessment and management of community health, safety and well-being impacts is increasingly considered part of the risk management and social responsibility of applicants. A range of industrial sectors e.g., oil and gas, chemical manufacturing and transportation are increasingly looking to embed HIA within their organizational and project management structures. For new projects and modifications, or acquisitions of existing projects, HIA can:

- Identify and maximize the positive community health and well-being impacts and opportunities that a proposed project can bring.
- Identify, avoid and minimize, through changes to the project design and implementation, the unintended negative community health and well-being impacts that can arise.
- Identify existing community health problems, which could amplify the impact of a proposed project and affect its viability.
- Identify country-specific health regulations which may affect the proposed Crematorium Project.
- Provide a process through which the project can work in partnership with local health, social care, and welfare services to jointly alleviate these health problems.
- Form one part of a broader community and local stakeholder involvement and engagement process that can build trust, draw out any community concerns and generate a dialogue about the best ways that the project can benefit local communities.
- Help to make explicit the potential trade-offs between community health and well-being and other economic, environmental and social objectives of the proposed Crematorium Project.
- Provide an equitable, transparent and evidence-based approach to planning and funding community health infrastructure and development activities to protect and enhance sustainable local livelihoods.
- Help to negotiate jointly those aspects of community health and well-being which are the responsibility of the project and those aspects which are the responsibility of local government and local public services.
- Help to manage project sustainability and obtain a long-term licence to operate.

A proactive approach to preventing ill health and maximizing health and well-being benefits can improve the financial performance of a project and parent company. Key bottom-line benefits include:

- Speedier achievement of a project's licence to operate
- Lower planning and associated legal and consultancy costs
- Access to international funding
- Lower risk of disruptive protest or sabotage
- Lower risk of damage to a project and parent company's reputation
- Lower risk of future community-led liability and litigation
- Reduced absenteeism and health care costs for employees from local communities
- Improved general employee morale.

7.7 Determining the scale of the HIA

The level or scale of a HIA depends on the complexity of the Project, the magnitude of expected impacts, as well as the Project phase during which the HIA is undertaken. Various levels of HIA are defined in Table 7-1 below (IFC, 2012).

When gathering new field data for the HIA, the Project will require different levels of effort and needs. The key descriptive terms for these cases— "comprehensive" and "rapid appraisal"—indicate the different depths of analysis and consultation required, and whether the performance of the HIA involves collecting new field data.

In Figure 7-5, the 'potential health impact' axis considers health issues in the Project location, such as:

- Hazardous materials exposure—how the crematorium will operate, and what the exposures to physical, biological, and chemical agents will be;
- Endemic disease profile;
- HIV/AIDS, tuberculosis, schistosomiasis, etc.;
- Health systems and infrastructure—poor or non-existent health infrastructures; and
- Stakeholder concerns—critical community issues, such as water quality or access, increased road traffic and accidents.

The 'social sensitivity' axis in Figure 7-5 covers a broad range of issues, many of which are typically addressed within the social analysis of the potentially affected communities (for example, conflict, resettlement, political factors, vulnerable communities, human rights, and equity concerns). The vulnerable status includes factors such as gender, ethnicity, culture, sickness, physical or mental disability, poverty or economic disadvantage, and dependence on unique natural resources (IFC, 2012).

Since the Project is a relatively small and no influx of new residents is expected, a Rapid Appraisal HIA was deemed necessary.

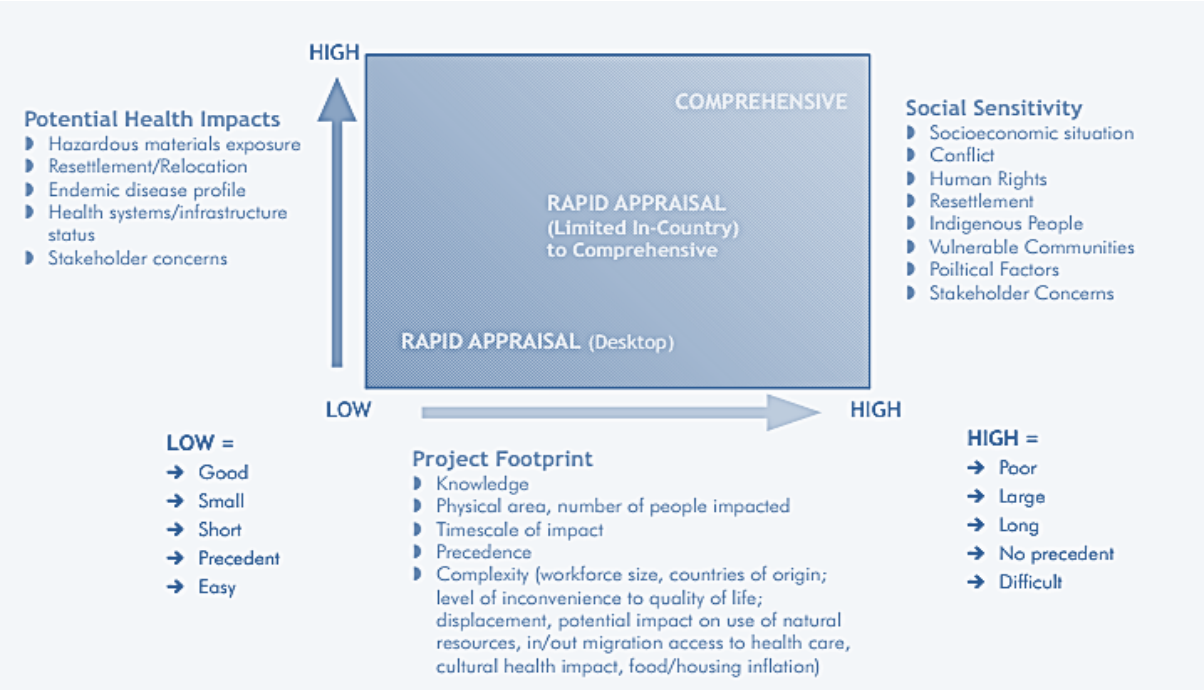


Figure 7-5: Selecting a HIA Type

The level or scale of a HIA depends on the complexity of the Project, the magnitude of expected impacts, as well as the Project phase during which the HIA is undertaken. Various levels of HIA are defined in the table below (IFC, 2012). When gathering new field data for the HIA, the Project will require different levels of effort and needs. The key descriptive terms for these cases -- "comprehensive" and "rapid appraisal" -indicate the different depths of analysis and consultation required and whether the performance of the HIA involves collecting new field data.

The preferred approach for assessing potential community health impacts from the proposed Project is the Scoping/Rapid Appraisal HIA which uses information that is readily accessible in the public domain. Data sources may include peer-reviewed scientific literature and "grey literature," that is, health department data. Although no specific new data collection is required, workshops or discussions with key internal and external stakeholders can provide useful health-related information. Limited in-country HIAs are appropriate for many expansion scenarios where new data collection is not crucial (IFC, 2009). The activities undertaken in the Scoping/Rapid Appraisal HIA are highlighted in Table 7-1 and formed the basis for this study.

Table 7-1: Levels of HIA (IFC, 2009)

Level of HIA	Characteristics
Desktop HIA	• Provides a broad overview of possible health impacts; • Analysis of existing and accessible data; and • No new Project specific survey data collection.
Scoping/Rapid Appraisal HIA	• Provides more detailed information of possible health impacts; • Analysis of existing data; • Stakeholder and key informant analysis; and • No new Project-specific survey data collection.
Comprehensive HIA	• Provides a comprehensive assessment of potential health impacts; • Robust definition of impacts; • New Project specific survey data collection; and • Participatory approaches involving stakeholders and key informants.

7.8 Stakeholder Analysis

Stakeholders are vitally important throughout the entire HIA process. The experience and expertise of a wide range of stakeholders and key decision makers are necessary as it aids in identifying potential concerns and hazards surrounding human health. Public participation ensures that community concerns are noted and addressed. Stakeholders whom have been identified for the proposed Crematorium include some of the following:

- Community representatives
- Potentially Affected Communities
- NGOs
- Representatives from various authorities ranging from local to national government

7.9 Baseline Data Collection

The data collection activities of the HIA included a desktop literature review. This method allows for the triangulation of data and provides a robust description of data as shown in

Figure 7-6 (Winkler *et al*., 2011).

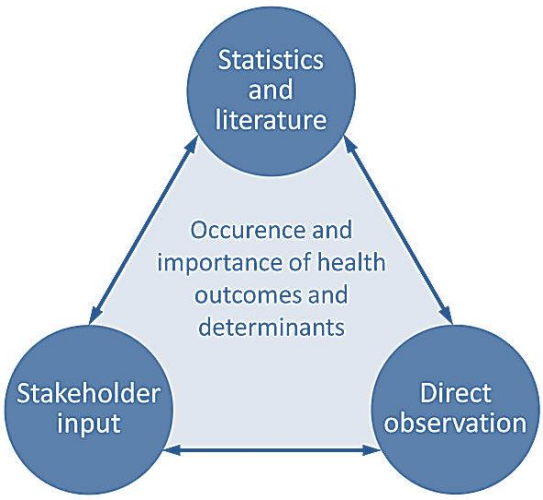


Figure 7-6: Triangulation of Data (Winkler *et al*., 2011)

7.9.1 Desktop Work

This involved a literature review of health-related data in the public domain as well as a review of existing Project documentation and related secondary data. Priority was given to topics that contributed the most towards the burden of disease in South Africa and the proposed Crematorium Project site and also to health-related incidents related to emissions from crematoriums in general. The desktop work included an extensive literature review to inform the health profiling of the region and where possible the population in the proposed Crematorium Project site. The desktop work described the broad health status of the population, based on a systematic review of the 12 EHAs. The outcomes of the literature review are presented in this Report and have been combined with the information that was acquired during the field visit and subsequent Project documentation review.

The key aspects when considering the potential influence of the project to the PACs is the exposure pathway of the potential health determinant. The following key elements have been considered:

- Whether there is a hazard;
- Who or what may be exposed to this hazard (pathway and rate of exposure to estimate the concentration/extent to which human receptors of concern may be exposed);

- The mode (air, water, food, vector, social determinants etc.) and route (inhalation, ingestion etc.) of exposure;
- The risk of exposure; and
- How sensitive or vulnerable the receptor is to the potential hazard or impact.

7.10 Potential Impact Categorisation: Environmental Health Areas (EHAs) Framework

Potential community health impacts were identified on the basis of: (i) the available health data from the literature review; (ii) the information generated through stakeholder consultation; (iii) the knowledge of the Project context and developments; (iv) input from other specialist studies that inform the elements of the EIA; and (v) experience of previous HIAs in similar settings (Winkler *et al*., 2010).

The identified potential impacts were then categorised in terms of 12 Environmental Health Areas (EHAs) – a set of health-related factors and considerations defined by IFC methodology. These are summarised in Table 7-2. The set of EHAs provides a linkage between Project-related activities and potential positive or negative community-level impacts, and incorporates a variety of biomedical and key social determinants of health. In this integrated analysis, cross-cutting environmental and social conditions that contain significant health components are identified instead of a HIA focusing primarily on disease-specific considerations – as is frequently done in many biomedical analyses of potential Project-related public health impacts. The EHA framework is based on an analysis performed and published by the World Bank (IFC, 2009).

Table 7-2: Environmental Health Areas

Environmental Health Areas (EHAs)	
1.	**Vector-related diseases** – Mosquito, fly, tick and lice-related diseases (e.g., malaria, dengue, yellow fever, lymphatic filariasis, rift valley fever, etc.).
2.	**Acute respiratory infections and respiratory effects from housing** – Transmission of communicable diseases (e.g., acute respiratory infections, pneumonia, tuberculosis, meningitis, plague, leprosy, etc.) and respiratory infections.
3.	**Veterinary medicine and zoonotic issues** – Diseases affecting animals (e.g., bovine tuberculosis, swinepox, avian influenza) or that can be transmitted from animal to human (e.g., rabies, brucellosis, Rift Valley fever, Lassa fever, leptospirosis, etc.).
4.	**Sexually-transmitted infections, including Human Immunodeficiency Virus/ Acquired Immune Deficiency Syndrome (HIV/AIDS) –** Sexually-transmitted infections such as syphilis, gonorrhoea, chlamydia, hepatitis B and, most importantly, HIV/AIDS. Linkages of TB will be discussed where relevant under HIV, but often linked to EHA1.
5.	**Soil-, water- and waste-related diseases** – Diseases that are transmitted directly or indirectly through contaminated water, soil or non-hazardous waste (e.g., diarrheal diseases, schistosomiasis, hepatitis A and E, poliomyelitis, soil-transmitted helminthiases, etc.).
6.	**Food- and nutrition-related issues** – Adverse health effects such as malnutrition, anaemia or micronutrient deficiencies due to e.g., changes in agricultural and subsistence practices, or food inflation; gastroenteritis, food-borne trematodiases, etc. This will also consider feeding behaviours and practices.
7.	**Accidents/injuries** – Road traffic or work-related accidents and injuries (home and Project related); drowning.
8.	**Exposure to potentially hazardous materials, noise and malodours** – This considers the environmental health determinants linked to the Project and related activities. Noise, water and air pollution (indoor and outdoor) as well as visual impacts will be considered in this biophysical category. It can also include exposure to heavy metals and hazardous chemical substances and other compounds, solvents or spills and releases from road traffic and exposure to mal-odours. There is a significant overlap in the environmental impact assessment in this section. Ionizing radiation also falls into this category.
9.	**Social determinants of health** – Including psychosocial stress (due to e.g., resettlement, overcrowding, political or economic crisis), mental health, depression, gender issues, domestic violence, suicide, ethnic conflicts, security concerns, substance misuse (drug, alcohol, smoking), family planning, health seeking behaviours, etc. There is a significant overlap in the Social Impact Assessment (SIA) in this section.

Environmental Health Areas (EHAs)	
10.	**Cultural health practices** – Role of traditional medical providers, indigenous medicines, and unique cultural health practices.
11.	**Health systems issues** – Physical health infrastructure (e.g., capacity, equipment, staffing levels and competencies, future development plans); program management delivery systems (e.g., malaria-, TB-, HIV/AIDS-initiatives, maternal and child health, etc.).
12.	**Non-communicable diseases** – Cardiovascular diseases, cancer, diabetes, obesity, etc.

7.11 Direct versus Indirect and Cumulative Effects

The purpose of an HIA is to 'unravel the determinants of health, which include individual, social and environmental, and institutional factors, that are directly or indirectly (representing underlying issues), and cumulatively affected by the proposed project. Consideration of these aspects allows for better management of the risks associated with individual determinants' (IFC, 2009).

Numerous health determinants are affected by individual factors which may be genetic, biological, lifestyle or behavioural in nature, and specific circumstances (IFC, 2009). These factors include indicators of vulnerability that describes individual exposure, susceptibility or the ability to cope. Examples include gender, age, dietary intake, exercise, alcohol and tobacco use, education, and employment. The relationship between a project and the individual determinants is complex and often controversial. 'The HIA is not a "social engineering" exercise; instead, the assessment aims to systematically analyse those potential direct, indirect (underlying), and cumulative community impacts that are predicted to occur due to the project' (IFC, 2009).

Activities identified for the project during the construction, commissioning, operational and decommissioning phases have been used to identify relevant generic key issues as recommended by the IFC HIA Guidelines (IFC, 2009). Associated EHAs and their implications in terms of the project activities were then used to guide the selection of potential positive and/or negative impacts.

7.12 Data Gaps and Limitations of the HIA Study

This Baseline HIA has focused on understanding the high-level health issues associated with the proposed Crematorium Project site.

The gap analysis included a critical appraisal of data quality of sources identified during the HIA process.

The following are the recognised limitations of the HIA study:

- The HIA study often refers to local level data which has some limitations that need to be understood and respected. Recording and reporting of the health data within the visited Healthcare facilities is completed manually, and it is likely that the recording may lack required accuracy. However, this information is invaluable in understanding the health challenges in the area, although the limitation must be considered

when evaluating information, as its ability to be used as a robust baseline and to monitor relevant health impacts is limited.

This HIA must be viewed as a prospective / predictive study as there has as yet been no initiation of any construction activities on the proposed site.

8. Country Health Profile: South Africa

Since the end of apartheid in 1994, South Africa has experienced notable changes in population health. The first years of post-apartheid South Africa were characterised by economic growth and noteworthy steps towards reducing inequalities in health and high levels of mortality from infectious and maternal causes. Unfortunately, the emergence of the HIV/AIDS epidemic during the early 2000s, prior to the rollout of antiretroviral drug therapy (ART), resulted in massive shocks to the health system and reversed many previous gains in health. Concerted efforts by successive administrations, coupled with international support, have stabilised the epidemic and have begun to shift health policy towards longer-term strategies and goals that now include a wider range of priorities such as non-communicable disease (NCD) prevention and National Health Insurance (NHI)—South Africa's approach to achieving universal health coverage (ibid).

South Africa is a dynamic and complex country. A middle-income nation that has dedicated substantial resources to health and human capital investments, South Africa has a progressive Constitution that guarantees the right to health care and a vibrant civil society. National Health Insurance (NHI) is the central means by which the government aims to achieve universal coverage, under the principles of social solidarity and equity elaborated in the National Development Plan. To implement NHI, the government is revitalizing service delivery, changing the way that health services are financed, ensuring the provision of primary care, improving access to qualified human resources for health, and ensuring the availability of quality assured medical products.

Life expectancy has increased due to innovations and rapid scale-up of HIV/AIDs and Tuberculosis (TB) treatment and care, and expanded access to immunizations. Life expectancy which incorporates the impact of AIDS increased from 52.1 years in 2005 to 61.2 years in 2014 (Statistics South Africa, 2014). The estimated national HIV prevalence among the general population aged 15 – 49 years has remained 17.3% since 2005 (Department of Health Strategic Plan 2014/15-2018/9). Two in three TB patients also are HIV positive. South Africa has one of the highest TB incidence rates in the world (834 per 100,000 populations). The treatment success rate for new and relapse cases registered in 2013 is 78% (Global TB Report 2015).

South Africa also contributes about 10.4% of the global burden of reported Multi-drug Resistant Tuberculosis (MDR-TB) initiated on treatment. A National DRTB Survey to ascertain the burden of DR-TB was made available in the first quarter of 2016. Diagnosis and management of drug resistant cases account for nearly half of the TB budget, and treatment success rates are 49% for MDR-TB and 20% for XDR-TB (Global TB Report, 2015).

Progress in maternal and child health has been hindered by the HIV and tuberculosis epidemics, and the performance of the health system. Efforts to accelerate prevention interventions are underway, including the prevention of maternal to child transmission of HIV. Important reductions have occurred in under-five and neonatal mortality (42 and 14 per 1000 live births (2013/14)), although these rates are higher in comparison with other countries of similar socioeconomic status. Maternal mortality ratios remain high, estimated at 269 deaths per 100 000 live births. Immunization remains critical to improving child health. The government currently has eleven antigens on its national immunization schedule, including rotavirus and Pneumococcal Conjugate Vaccine, which has markedly reduced child morbidity and mortality. A national HPV campaign was launched in March 2014.

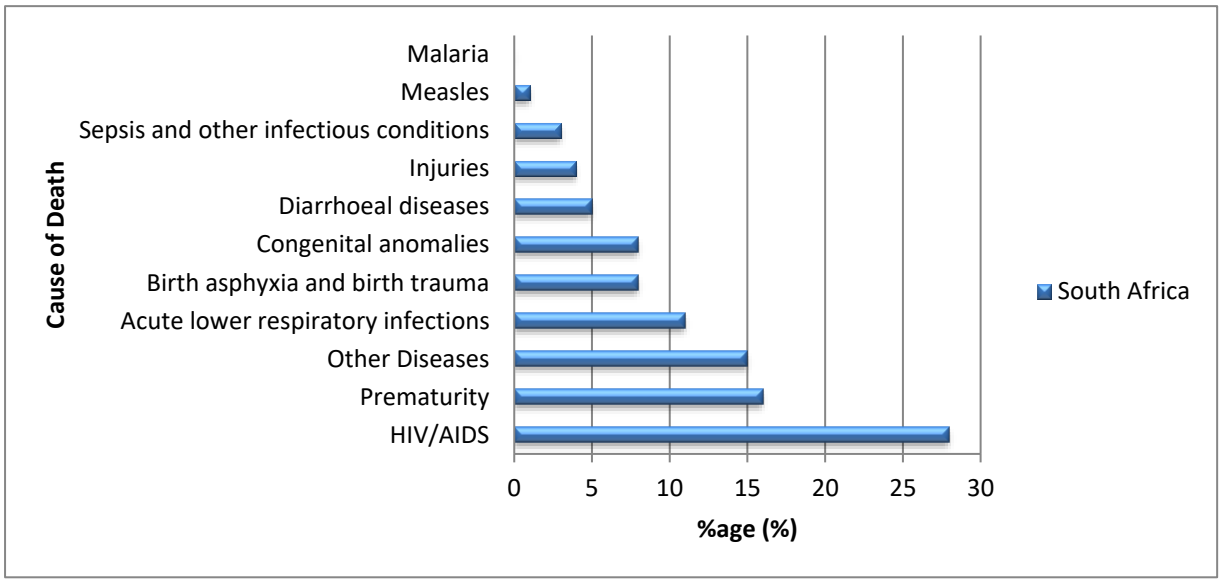


Figure 8-1: Distribution of causes of death among children aged under 5, % of totals in RSA

Approximately two in five deaths are attributable to non-communicable diseases. Some 40% of mortality from non-communicable conditions among men occurred before the age of 60 years - and is therefore considered premature. Second to non-communicable conditions is the burden of mortality and disability from violence and injuries. A rapid increase in motor vehicles has led to increases in road traffic accidents that now account for more than one-quarter of deaths due to injuries. For nearly two decades, tobacco-use declined because of strong legislation and policies to control tobacco consumption. The WHO FCTC was ratified in 2005. However, smoking rates are among the highest in the continent (21.5% in 2014). Harmful alcohol consumption is the third most important risk factor contributing to non-communicable diseases, injuries, and communicable diseases. Alcohol use is a major underlying factor in injuries and road traffic accidents. Patterns of harmful use exist among those who drink. Harmful and excessive alcohol consumption also contributes to non-communicable conditions, and can also accelerate the progression of infectious diseases.

Overweight and obesity pose major nutritional challenges. More than seven in ten women above 35 years old are overweight. A contributing factor is the rapidly increasing consumption of packaged foods high in calories,

saturated fats, animal proteins, sugars, and salt. In addition, physical activity levels are low. Approximately half of adults are physically inactive, and two in five schoolchildren do not participate in sufficient physical activity. Improvement in the sustainable development sector has resulted in improved quality of life. Access to improved water sources is nearly universal. However, coal is used as a cheap source of energy for industry, and thus South Africa ranks as the highest greenhouse gas emitter in the continent. Climate change is one of the key priorities of Government, who views mitigation to ensure an internationally competitive lower carbon economy.

8.1. Burden of Disease

GBD 2019 estimated the incidence and prevalence of a range of disease, injuries, and sequelae, summarised here in YLDs. Population growth and ageing were key drivers of nonfatal disease burden: the total number of YLDs nationwide increased from 3.59 (95% UI 2.67–4.61) million in 1990 to 6.50 (4.86–8.37) million in 2019, while age-standardised YLD rates increased from 11 587 (8677–14 796) per 100 000 in 1990 to 12 053 YLDs (9046–15 474) per 100 000 in 2019. Trends in YLDs by province for specific causes of disability are illustrated in the Figure below. Aside from YLDs due to HIV/AIDS and its sequelae (including tuberculosis), which increased several orders of magnitude, the largest increases among leading causes of YLDs were from diabetes, chronic kidney disease, neonatal disorders and other musculoskeletal disorders.

The 21 leading causes of YLDs in 2019 (in descending order) are shown here, except for HIV/AIDS, which had annualised per cent change values that exceeded the scale of this figure by orders of magnitude. (A) Change over 1990–2007. (B) Change over 2007–2019. YLDs, years lived with disability.

All provinces except for North-West experienced a considerable increase in YLDs from NCDs between 2007 and 2019 from the combined effects of demographic change and rising age-specific prevalence of NCDs such as diabetes and chronic kidney disease. The largest increase in YLDs from NCDs was in Northern Cape at 3.8% (+3.5 to +4.0%) per year, while YLDs in North-West decreased at −0.6% (−0.4% to −0.8%). Due to their high prevalence, mental disorders as a group contributed to the largest total number of YLDs in all provinces, though their rate of increase between 1990 and 2019 was less pronounced than for other NCDs. Injuries accounted for about 4.6% of total YLDs in Limpopo and Northern Cape (the highest two provinces), as compared with 3.2% and 3.7% of total YLDs in KwaZulu-Natal and Mpumalanga (the lowest two provinces).

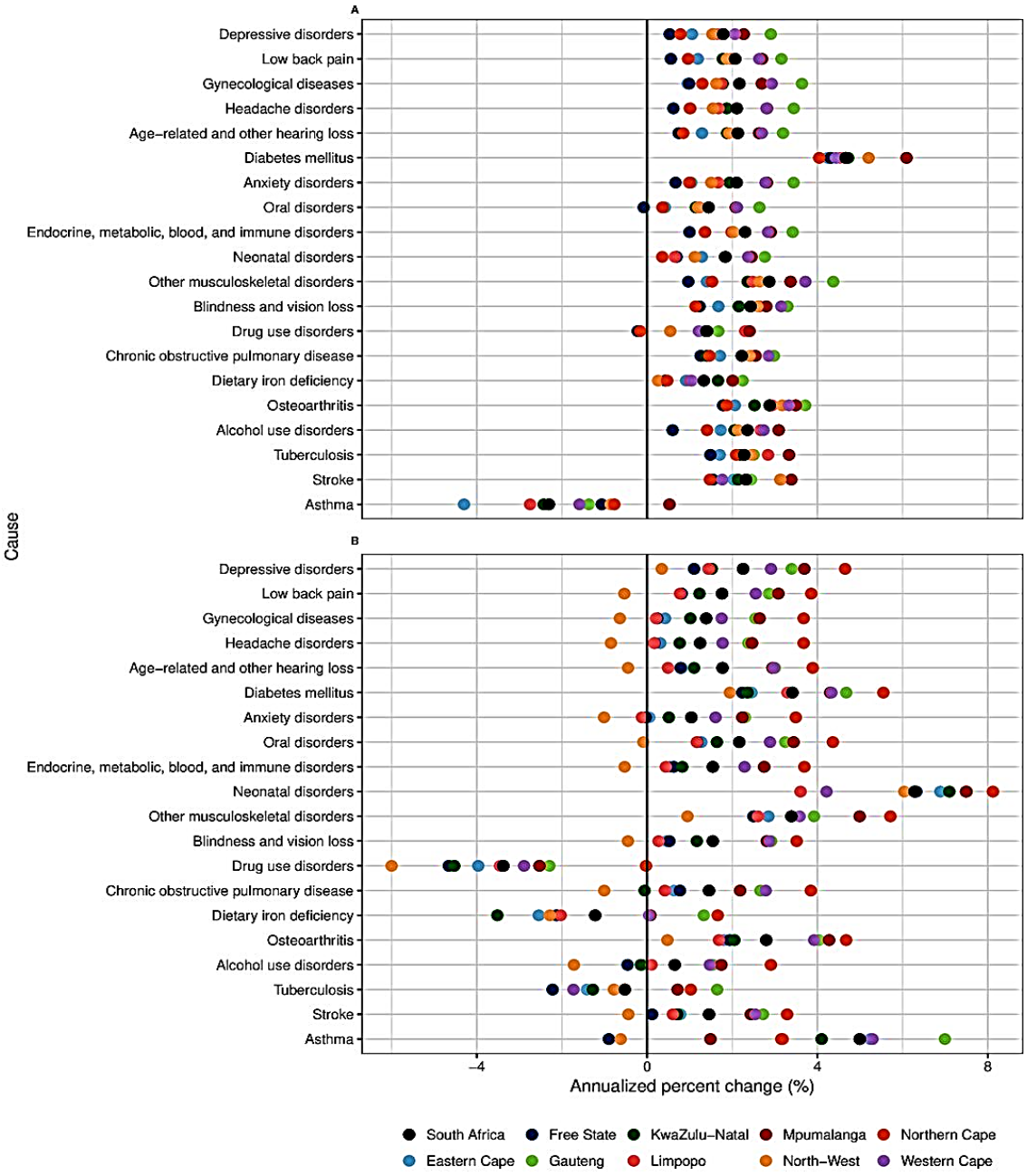
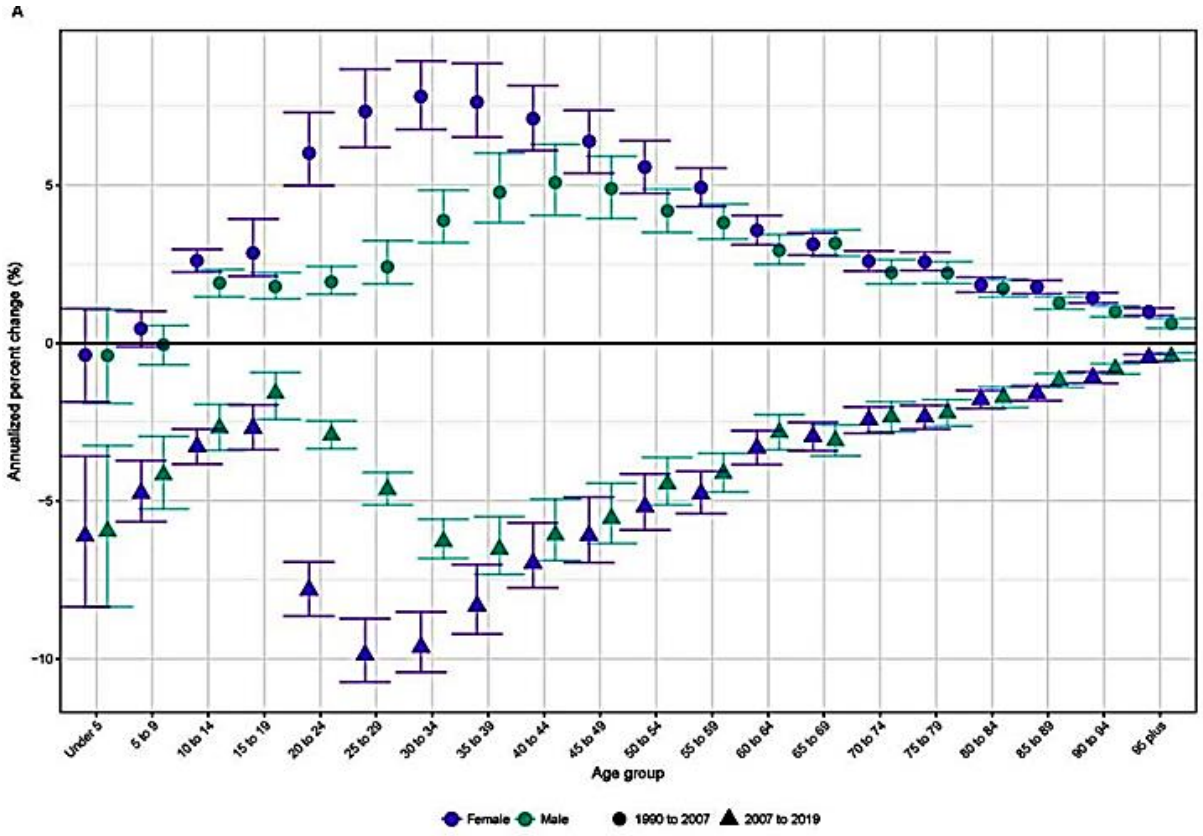


Figure 8-2: Annualised per cent change in YLDs (all ages, both sexes) by province, 1990–2019

8.2. Mortality Levels and Trends

The number of deaths in South Africa increased from 293 904 deaths (95% 280 307–308 060) in 1990 to 724 828 deaths (667 154–797 221) in 2007, then declined to 521 802 deaths (494 683–554 967) in 2019. Trends in all-cause mortality by age and sex (figure 1A) tracked reasonably closely with trends in HIV/AIDS-specific mortality (figure 1B), with increases in both between 1990 and 2007 and decreases in both between 2007 and 2019. Changes in all-cause mortality were most pronounced in working-age adults. The exception to these overall positive trends was a modest, although noteworthy, increase in mortality among adolescent males and females over 2007–2019.


A
Annualized percent change (%)
5
0
-5
-10
Under 5
5 to 9
10 to 14
15 to 19
20 to 24
25 to 29
30 to 34
35 to 39
40 to 44
45 to 49
50 to 54
55 to 59
60 to 64
65 to 69
70 to 74
75 to 79
80 to 84
85 to 89
90 to 94
95 plus
Age group
Female
Male
1990 to 2007
2007 to 2019

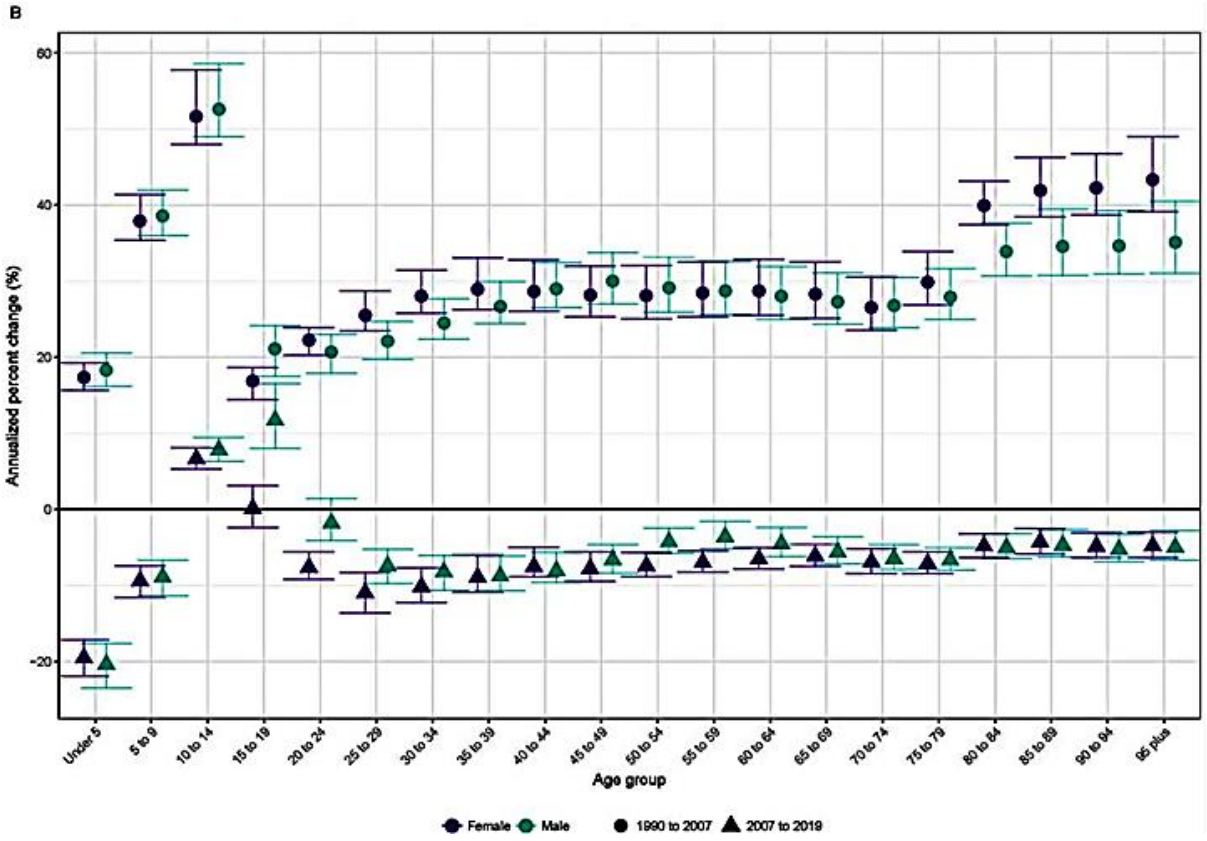


Figure 8-3: Annualised per cent change in age-specific and sex-specific mortality rates, 1990–2007 and 2007–2019

8.3. Public and Private Health Sector

South Africa has a large public sector and a smaller but fast-growing private sector. The country's Healthcare system comprises a network of health facilities providing primary health care, supported by several higher levels of care. Healthcare in South Africa varies from the most basic primary healthcare, offered free by the state, to highly specialised, hi-tech health services available in both the public and private sector.

The public health sector is stretched and under-resourced in several places. While the state contributes about 40% of all expenditure on health, the public health sector is under pressure to deliver services to about 80% of the population. The private sector, on the other hand, is run largely on commercial lines and caters to middle- and high-income earners who tend to be members of medical schemes (South Africa Info, 2013). It also attracts most of the country's health professionals.

This two-tiered system is not only inequitable and inaccessible to a large portion of South Africans, but institutions in the public sector have suffered poor management, underfunding and deteriorating infrastructure. While access has improved, the quality of health care has fallen. The situation is compounded by public health challenges, including the burden of diseases such as HIV and Tuberculosis (TB), and a shortage of key medical personnel.

8.4. Healthcare System Performance

Literature compares HAQ Index values for the year 1990 and 2019 across all nine provinces and with the other 15 SADC member countries (figure 5; online supplemental figure S5). In terms of overall performance, South Africa ranked third in 1990 and fourth in 2019, surpassed only by Mauritius and Seychelles in both years. However, HAQ Index values varied considerably between provinces, with the highest values in 2019 for Western Cape and KwaZulu-Natal (similar to Mauritius in 1990), and the lowest values for Free State, Northern Cape, and Eastern Cape (between Eswatini and Namibia in 2019). These three provinces also had the smallest improvements over time. By contrast, the largest improvements in HAQ Index were in KwaZulu-Natal, Mpumalanga and Gauteng; the only SADC neighbours that had a larger improvement than KwaZulu-Natal were Seychelles, Zambia, Botswana, Angola and Namibia.

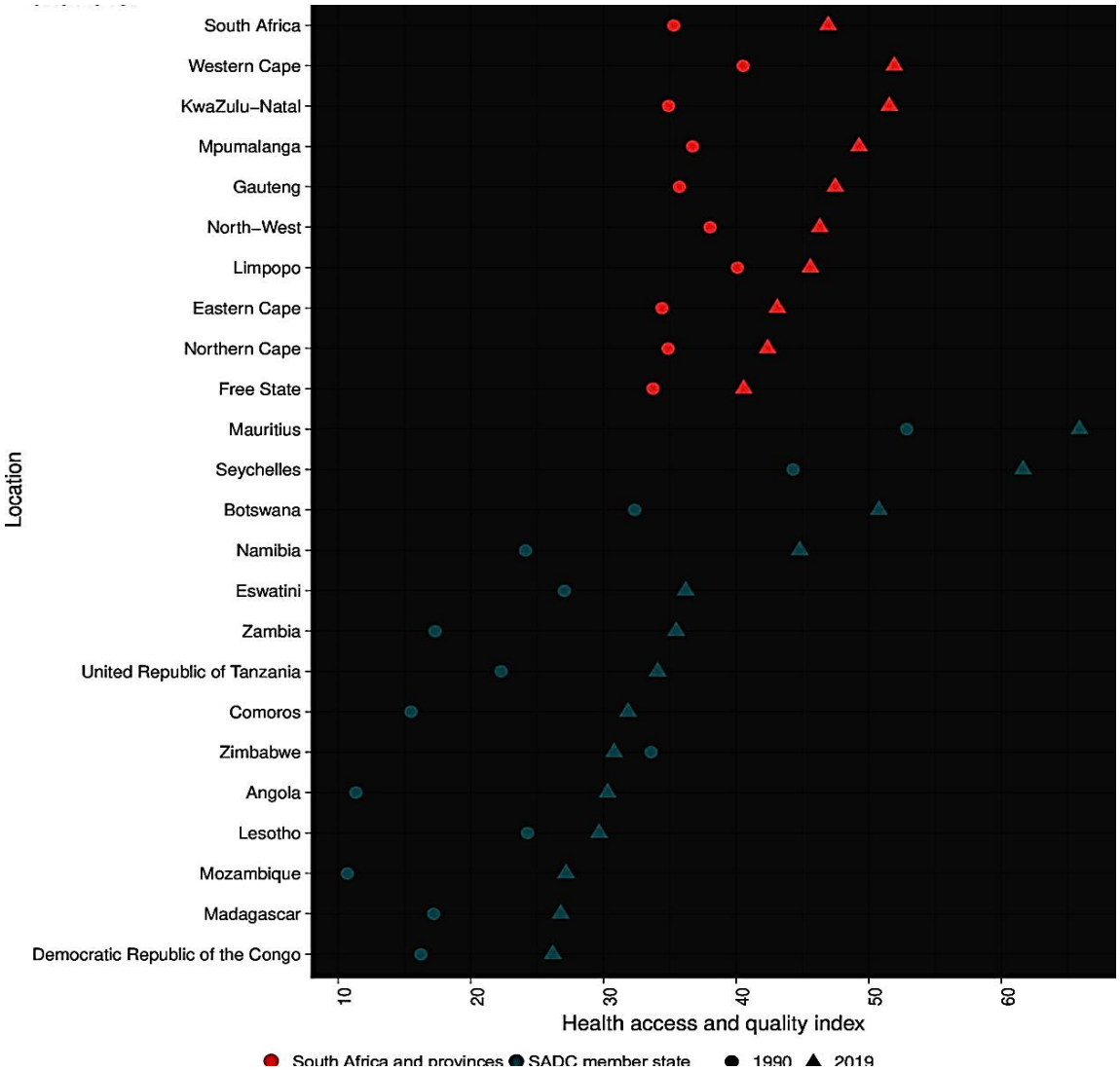


Figure 8-4: GBD healthcare access and quality index values for South Africa and provinces compared with Southern African Development Community member states, 1990 and 2019

The GBD healthcare access and quality index is a summary measure of health system performance that incorporates estimates of age-standardised and risk-standardised mortality rates for 32 causes that are amenable to healthcare. The index scale ranges from 0 to 100, with higher values indicating better performance. GBD, Global Burden of Disease; SADC, Southern African Development Community.

8.5. Healthcare Facilities

There are 4 200 public health facilities in South Africa. The number of people per clinic as per figures from 2013, was 13 718, exceeding WHO guidelines of 10 000 per clinic. However, figures from March 2009 show that people averaged 2.5 visits a year to public health facilities and the usable bed occupancy rates were between 65% and 77% at hospitals (South Africa Info, 2013).

Since 1994, more than 1 600 clinics have been built or upgraded. Free health care for children under the age of 6 and for pregnant or breastfeeding mothers was introduced in the mid-1990s (South Africa Info, 2013).

The National Health Laboratory Service (NHLS) is the largest pathology service in South Africa. It has 265 laboratories, serving 80% of South Africans. The laboratories provide diagnostic services as well as health-related research (South Africa Info, 2013).

8.6. Doctor Shortages

In March 2012, 165 371 qualified health practitioners in both public and private sectors were registered with the Health Professions Council of South Africa (HPCSA), the health practitioner watchdog body. This includes 38 236 doctors and 5 560 dentists (South Africa Info, 2013).

The doctor-to-population ratio is estimated to be 0.77 per 1 000. Due to the clear majority of General Practitioners – 73% – working in the private sector, there is approximately one practising doctor for every 4 219 people for public health care (South Africa Info, 2013). In response, the Department of Health (DoH) has introduced clinical health associates, midlevel health-care providers, to work in underserved rural areas.

Approximately 1 200 medical students graduate annually. In some communities, medical students provide health services at clinics under supervision (South Africa Info, 2013). Newly graduating doctors and pharmacists complete a year of compulsory community service in understaffed hospitals and clinics.

8.7. Quality of Services

Public health facilities in South Africa collectively scored less than 50% compliance with vital measures in two out of the six ministerial priority areas. These measures included: patient safety and security (34%) and positive and caring attitudes (30%) (DoH, 2012). The priority area waiting times scored the highest compliance to vital measures at 68%. Primary care facilities on average scored lower than hospitals in all priority areas. Overall, the facilities in

Gauteng province obtained the highest compliance score on quality (69%) while the Northern Cape reflected the lowest (40%) (DoH, 2012).

8.8. Functionality of Services

In terms of performance in the five functional areas (Clinical Services, Infrastructure, Management, Patient Care, Support Services and Clinical Care), the compliance score obtained by the country's facilities is the lowest for Clinical Services (38%) (DoH, 2012). Within Clinical Services, the area of Health Technology recorded the lowest compliance for both Primary Health Care (PHC) and hospital facilities followed by Pharmacy. This, and the low number of pharmacists working in public health facilities, needs urgent attention.

8.9. Health-related Sustainable Development Goal Targets

Health has been recognized as central to international development for more than 20 years, and major efforts have been made to reduce morbidity and mortality either universally, or through a focus on specific population subgroups (e.g., "the poor", "women and children") (World Bank, 1993).

The United Nations Sustainable Development Goals (UN SDGs, also known as the Global Goals) are 17 goals with 169 targets that all UN Member States have agreed to work towards achieving by the year 2030. They set out a vision for a world free from poverty, hunger and disease. Health has a central place in SDG 3 "Ensure healthy lives and promote well-being for all at all ages", underpinned by 13 targets that cover a wide spectrum of WHO's work. Almost all of the other 16 goals are related to health or their achievement will contribute to health indirectly.

Sustainable Development Goal 3 (SDG 3 or Global Goal 3), regarding "Good Health and Well-being" targets, indicators and progress include:

- Target 3.1: Reduce maternal mortality
- Target 3.2: End all preventable deaths under five years of age
- Target 3.3: Fight communicable diseases
- Target 3.4: Reduce mortality from non-communicable diseases and promote mental health
- Target 3.5: Prevent and treat substance abuse
- Target 3.6: Reduce road injuries and deaths
- Target 3.7: Universal access to sexual and reproductive care, family planning and education
- Target 3.8: Achieve universal health coverage
- Target 3.9: Reduce illnesses and deaths from hazardous chemicals and pollution
- Target 3.a: Implement the WHO framework convention on tobacco control
- Target 3.b: Support research, development and universal access to affordable vaccines and medicines
- Target 3.c: Increase health financing and support health workforce in developing countries
- Target 3.d: Improve early warning systems for global health risks

Figure 8-5: Sustainable Development Goals

Figure 8-6 plots the observed average annualised rate of change (ARC) (2015–2019) in key quantitative SDG-3 targets by province and compares these to the rate of change that is needed to achieve the target. The Global Burden of Disease estimates that all nine provinces are currently on track to achieve the NCD target, and five are on track to achieve the under-5 mortality rates (U5MR) target. Two provinces at most are currently on track to achieve neonatal mortality and maternal mortality ratio (MMR) targets, respectively. HIV incidence declined quite slowly over 2015–2019, and tuberculosis incidence increased, suggesting these targets will be very challenging to achieve.

This analysis adds to the literature on mortality in South Africa and represents the largest systematic effort to date to quantify levels and long-term trends in nonfatal outcomes, risk-attributable burden, and comparative healthcare system performance in South Africa and its provinces. As in other countries, a subnational lens on health progress is important in South Africa because of considerable health inequalities and decentralisation of health planning and policy. South Africa is committed to achieving the health-related Sustainable Development Goals (SDGs). Achieving SDG targets necessitates monitoring of health outcomes and associated risks, as well as inequality in health infrastructure and inequitable access to services. One practical use of these subnational estimates is to identify which provinces are on track to achieve specific SDG targets to provide opportunities to share best practices and shore up disease-specific programmes in provinces that are off-track. It was found that most health indicators varied greatly by province, with poorer and more rural provinces generally showing lower levels of health and less progress since 1990.

While all provinces have made progress on HAQ since 1990, economically advantaged provinces have generally progressed at a faster rate, and performance in disadvantaged provinces has lagged behind neighbouring middle-income SADC countries. Many of the inequalities within and across provinces in South Africa are also due to the fragmented nature of the health system, with an under-resourced public health sector serving most of the people and a well-resourced private sector serving a minority of the population. The NHI provides a vital opportunity to close these gaps by integrating the public and private sector financing. In addition, the COVID-19 pandemic has stressed a fragile healthcare system and has highlighted the ‘syndemic’ nature of South Africa’s quadruple burden of disease by exposing the dominant role of shared risk factors (like harmful alcohol use) and social-structural vulnerabilities in driving disease and injury trends. Further, significant contraction of the local and regional economies is expected to exacerbate inequities in access to healthcare for the most vulnerable.19 20 Together, our findings suggest that a doubling-down on investments in key health programmes is needed in nearly all provinces, especially the least advantaged—and these investments are particularly urgent in the wake of COVID-19-related health service disruptions.

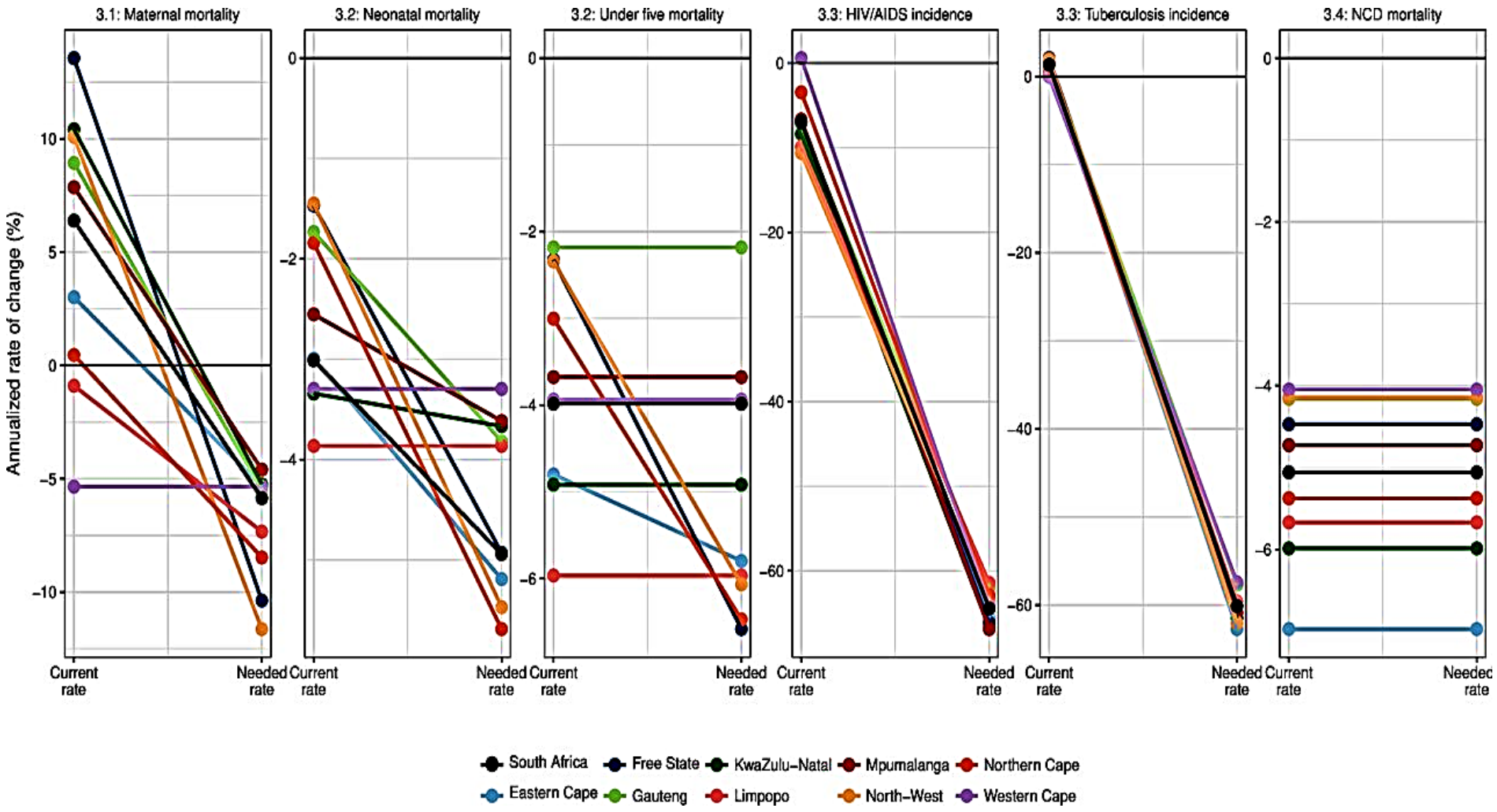


Figure 8-6: Progress towards achievement of key health-related sustainable development goal targets in South Africa and provinces

Unsurprisingly, the impact of HIV/AIDS and concurrent tuberculosis still dominate much of the quadruple burden of disease in South Africa and remain major drivers of changes in population health. Our analysis confirms that the national response to HIV/AIDS after 2007, including the rollout of ART, significantly improved life expectancy thereafter. It was also found an increase in the burden of HIV/AIDS and tuberculosis among adolescents, suggesting that more intensive, integrated efforts are needed for prevention and treatment in this age group. Given the rapid rises in NCDs and associated risk factors, integrated care for adolescents should also have a strong emphasis on NCD prevention. Furthermore, while significant progress has been made in controlling tuberculosis among people living with HIV, in part because of expanded ART, limited progress has been made in controlling tuberculosis in HIV-negative populations. This further supports the need for strategies targeting other non-HIV risk factors associated with tuberculosis that are increasingly prevalent, such as diabetes and alcohol abuse. The COVID-19 response in South Africa will need to ensure greater support for people living with HIV and that the HIV care continuum is not significantly disrupted and intensify efforts to prevent a resurgence in tuberculosis in 2021 and beyond.

Maternal and child survival has been an area of success since 1990, though most provinces do not appear to be on track to meet the SDG targets. To some extent, recent progress reflects the rollout of ART, including prevention of mother-to-child transmission, coupled with increased coverage of core Expanded Programme on Immunisation vaccines and, more recently, pneumococcal conjugate and rotavirus vaccines.27 28 Crucially, stay-at-home orders that have been implemented to limit the spread of COVID-19 could significantly disrupt immunisation activities, thus increasing the risk of children contracting other infectious diseases, as documented in Pakistan, for example. A recent modelling study found that the risk of COVID-19 death in the context of receiving immunisation services was far outweighed by the risk of death from a vaccine-preventable disease that resulted from not receiving these services. To prevent increases in child mortality from vaccine-preventable diseases, the Department of Health will need to assess where provincial and sub-provincial immunisation services have been most disrupted and redirect resources to targeted, mop-up campaigns.

Injuries, especially from interpersonal violence, have been a consistent feature of the South African landscape over the past 25 years. Evidence suggests that violence can increase during and in the aftermath of disease pandemics, as has been observed in the context of COVID-19-related lockdown/stay-at-home orders, suggesting a nuanced approach to COVID-19 mitigation will be required to balance direct and indirect health effects.30 The single most important risk factor for injuries in South Africa is a high prevalence of harmful use of alcohol. While WHO and others acknowledge alcohol taxes and regulations as ‘best buys’ in terms of their population health impact, practical challenges remain in implementing these policies in the South African context. Alcohol consumption remains a primary form of recreation for many and is strongly linked to perceptions of masculinity; a large local alcohol industry also ensures easy access. Past efforts to reduce alcohol and drug abuse locally have generally failed to combine interventions targeting high-risk persons and groups with population-wide approaches

to reduce per-capita consumption. Further, alcohol policies may have limited impact without concurrent efforts to address firearm possession and use, or to de-link heavy drinking from gender norms. Integrated alcohol and firearm control policies, combined with sustained public campaigns addressing drinking culture, will be necessary to reduce interpersonal violence, and they could generate extensive social and economic benefits.

The image also illustrates a rapid increase in nonfatal disease burden and NCD risk factors in all provinces, despite notable progress on reducing age-specific NCD death rates. These increases, driven by prevalent conditions like diabetes, have implications for health planning and resource allocation at the provincial level. Health promotion and prevention efforts are urgently needed in order to prevent a resurgence in NCD mortality and reduce fiscal pressures on NHI.35 Tobacco control was an early success story for South Africa, but more recently tobacco use as a risk factor has been replaced by obesity and physical inactivity. Dietary policies (including taxes, subsidies and regulations) and efforts to promote exercise through the built environment will probably have an outsized role in the intersectoral agenda in the coming years. In addition, a critical gap in the South African health system is the lack of integrated care for mental disorders at the primary level, a highly-specific, evidence-based, best-buy intervention were almost 27 million cases globally and almost 900 000 deaths, with virtually all countries affected. At this point, North and South America and Southeast Asia had the largest number of people infected with the virus.

8.10. Covid-19

Coronavirus disease 2019 is a contagious disease caused by a virus, the severe acute respiratory syndrome coronavirus 2. The first known case was identified in Wuhan, China, in December 2019. The disease has since spread worldwide, leading to an ongoing pandemic (WHO, 2021).

The first case of COVID-19 was reported to the World Health Organization (WHO) in December 2019 from Wuhan City, Hubei Province in China, and in January 2020 the WHO declared the COVID-19 outbreak a public health emergency of international concern. The first case of COVID-19 in South Africa was detection on the 5th March 2020, and the announcement was made by the WHO on 11 March 2020 characterising COVID-19 as a pandemic, the President of South Africa declared the pandemic to be a national disaster on 15 March 2020.

The pandemic has had devastating socio-economic costs; an estimated 2.8 million South Africans have lost their jobs. South Africa's budgetary and Public Finance Management systems channelled the allocation of more than R20 billion to the health sector COVID-19 response and an additional R100 billion has been spent on income support through new social grants.

COVID-19 has placed an even greater strain on South Africa's overburdened and under-resourced health system and has stymied the progress the country has made in strengthening health systems towards achieving universal health coverage. It has also disrupted access to health care for chronic conditions, including non-communicable diseases, testing, treatment initiation, and continuity of care for HIV and TB, as well as for sexual and reproductive

health services, due to both travel restrictions and the re-orientation of healthcare services to respond to the pandemic.

Overall, findings show that the COVID-19 pandemic placed an additional burden on already resource-constrained healthcare facilities, with nurses enduring shortages of basic resources, rapid depletion and delayed restocking of COVID-19-related equipment, and additional strain due to staff shortages. Healthcare workers also experienced daily dilemmas and internal conflicts associated with the pandemic, which affected their health and well-being, and their ability to deliver services.

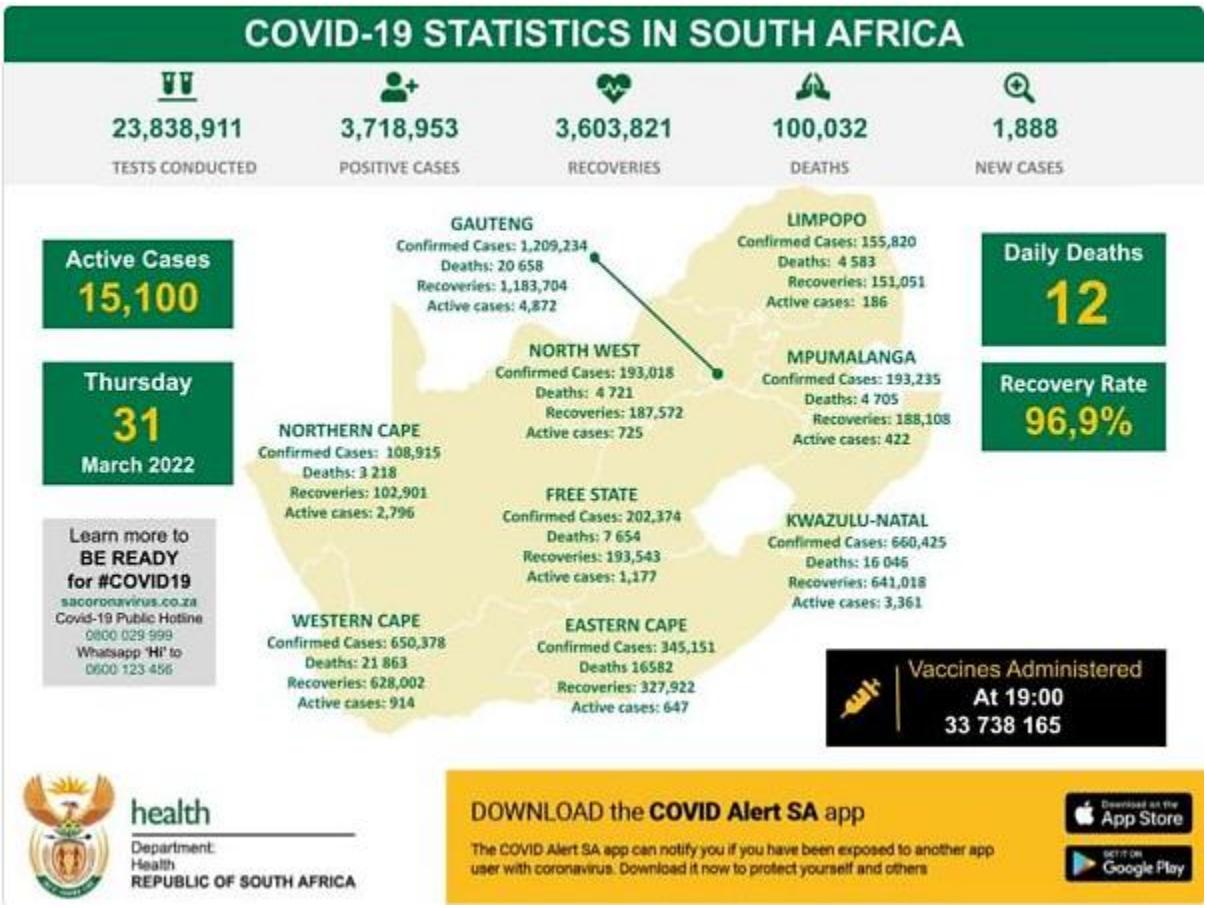


Figure 8-7: Update on Covid-19 (Thursday 31 March 2022)

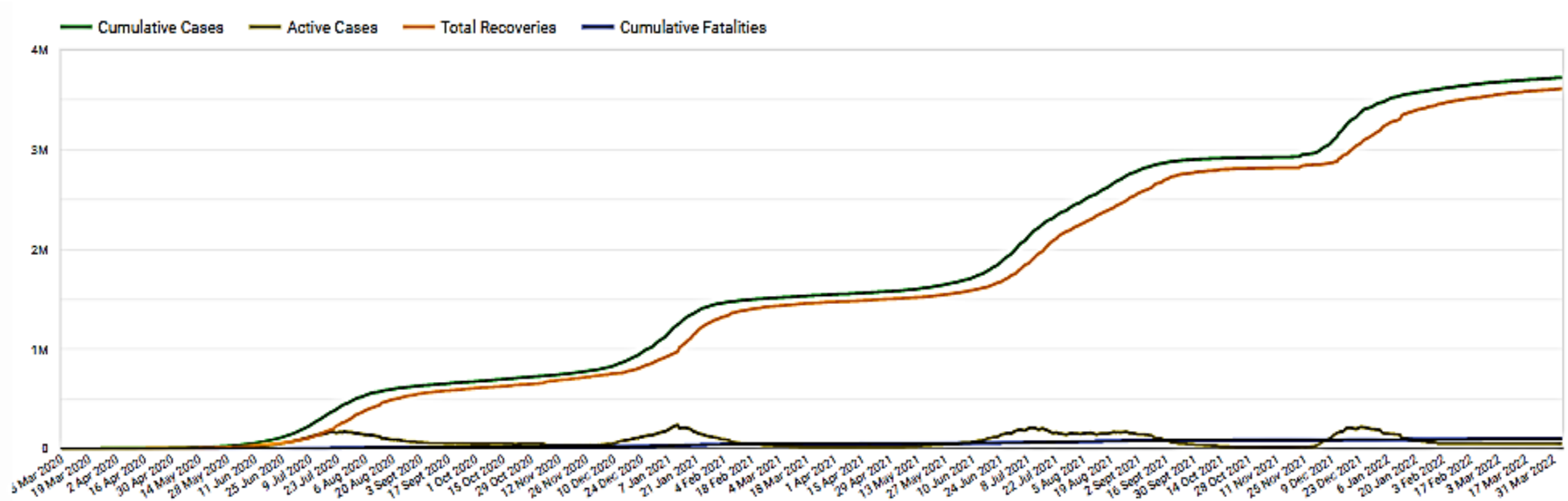


Figure 8-8: Recoveries and active cases of Covid-19 in South Africa

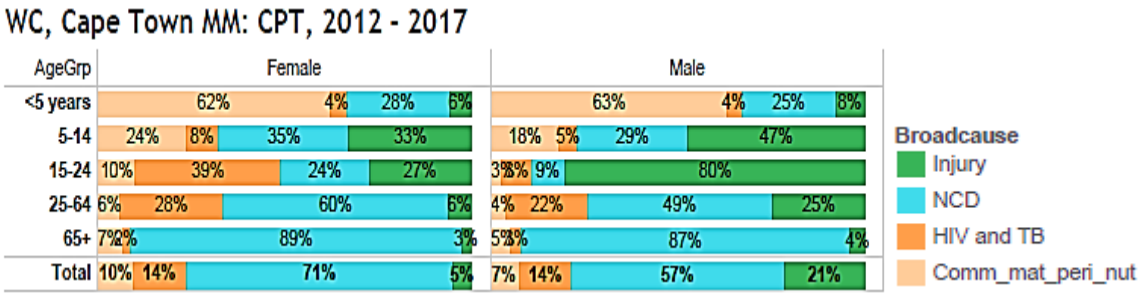
9. Regional Overview: City of Cape Town

The City of Cape Town Metropolitan municipality is situated on the southern peninsula of the Western Cape Province. The City of Cape Town Metropolitan Municipality incorporates eight health sub-districts, namely: Cape Town Eastern, Cape Town Northern, Cape Town Southern, Cape Town Western, Khayelitsha, Klipfontein, Mitchell's Plain and Tygerberg.

The main cities/ towns include: Athlone, Atlantis, Belhar, Bellville, Blackheath, Blouberg, Blue Downs, Brackenfell, Cape Point, Cape Town, Delft, Durbanville, Elsies Rivier, Fish Hoek, Goodwood, Gordon's Bay, Grassy Park, Guguletu, Hout Bay, Khayelitsha, Kommetjie, Kraaifontein, Kuils River, Langa, Macassar, Matroosfontein, Melkbosstrand, Milnerton, Mitchells Plain, Muizenberg, Noordhoek, Nyanga, Parow, Philadelphia, Philippi, Robben Island, Scarborough, Simon's Town, Sir Lowry's Pass, Somerset West, Southern Suburbs, Strand, and Table View.

9.1. Burden of Disease Profile

For the percentage of deaths by broad cause, deaths are classified into four groups, namely: (i) injuries; (ii) noncommunicable diseases; (iii) HIV and TB; and (iv) communicable diseases together with maternal, perinatal and nutritional conditions. Data are given by gender and age group for the period 2012–2017. The second part of the graph shows the 10 leading single causes of death within each age group and by gender for 2012–2017.



According to the 2017/18 District Health Barometer the Maternal Mortality rate was 58.3/ 100 000 live births, which is lower than the national average (105.7) and national average but higher than the provincial average (55.1). The maternal mortality rate has fluctuated between 56-65/100 000 over the past 5 years. The latest data for infant mortality shows a downward trend in the Cape Metro District over 2008 - 2013 and is amongst the lowest when compared to the province's other health districts. A similarly low and downward trend is seen in mortality under 5 years.

According to the Western Cape antenatal survey reports the Cape Metro had an antenatal HIV prevalence of 20.4% in 2014. Although this is much lower than the national average of 29.7% (2013) it is still the highest amongst all the province's districts. Khayelitsha sub district actually had a higher prevalence than the National average. The HIV prevalence was 18.2% in 2006 but seems to have stabilized at around 20% since 2011.

The TB case detection rate per 100 000 as set out below shows a heartening downward trend in recent years (J Caldwell, City of Cape Town). The district case load was 23 477 and the case detection rate 577/100 000 in 2016. Khayelitsha sub-district had the biggest proportional TB case load in 2016 and contributed 17% to the total case load of the city.

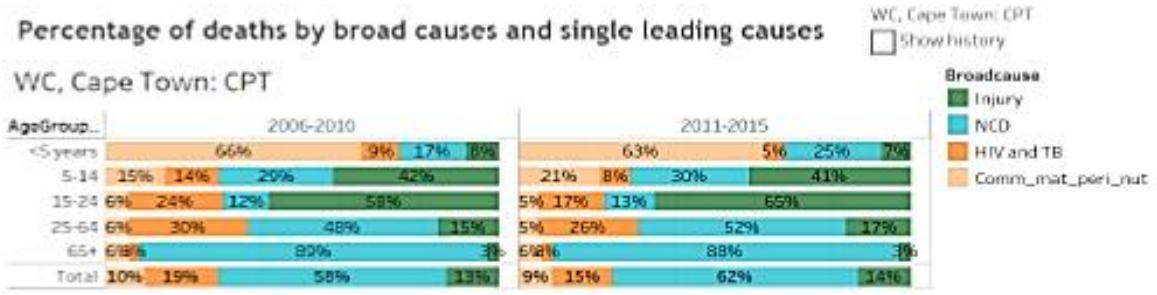


Figure 9-1: %age of deaths by broad causes and leading causes of death

The diagram above provides an overview of the %age of deaths by broad causes and leading causes of death. While non-communicable deceases are the leading cause of death in the ageing population at 88 and 62% respectively, injuries were the leading causes of death in the age cohort between 15 and 24 years. The main leading cause of death between the age cohort that is less than 5 years of age was maternal, perinatal and nutritional conditions.

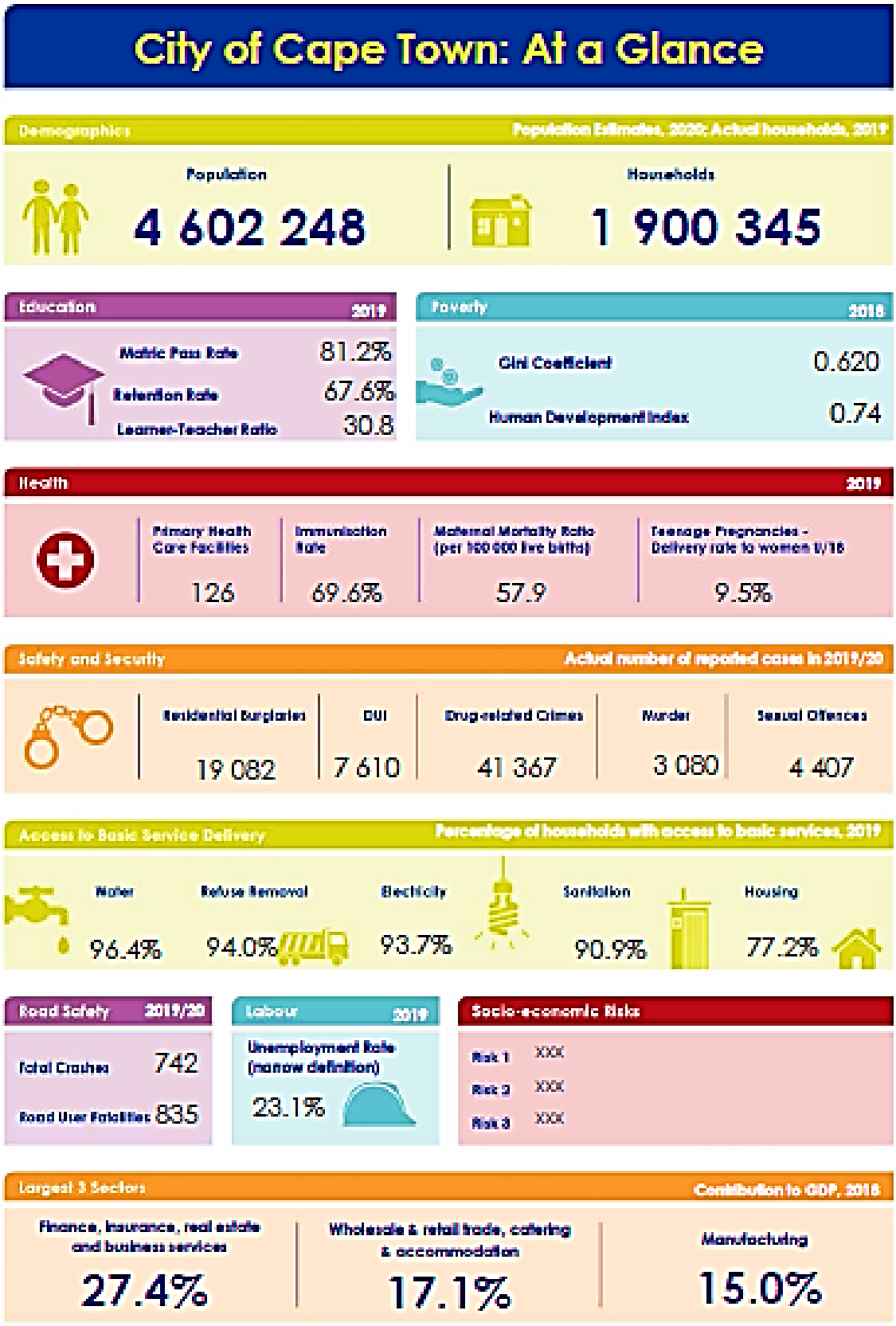


Figure 9-2: City of Cape Town Metropolitan Municipality Fact Sheet

9.2. Healthcare Facilities

The city had 126 primary health care clinics (PHC) IN 2019, which comprised of 69 fixed clinics (31 mobile/satellite),10 community unity health centres and 47-day centres.

9.3. Emergency Medical Services

Provision of more operational ambulances can provide greater coverage of emergency medical services. In 2019 the city had 116 EMS vehicles which equates to 4 per 10000 in habitants. This number only refers to provincial ambulances and excludes all private services providers.

9.4. HIV/AIDS/TB

The number of clients(patients) that remain committed to the antiretroviral treatment (ART) plan in the Cape Metro municipal area increased by 15600 patients between 2018/19 and 2019/2020. In total,210803 registered patients received antiretroviral treatment in the city in 2019.The number of new patients receiving ART however declined by 97 to 28758 patients in 2019/2020.There has been an average annual decline of 1.1 % between 2017/18 (237400 and 2019/20 (24264) in the number of registered patients receiving TB treatment in the city. The province as a whole experienced a 0.8 % decline a cross the same period.

9.5. Child Health

The immunisation coverage for children under the age of one in the cape metro improved notably from 66.4 % in 2018/19 to 69.6 % in 2019/20. The overall provincial rate also improved from 65.6 to 68.4% across the same period

The number of malnourished children under five years of age (severe acute malnutrition) per 100000 people in the Cape Metro increased slightly from 1 in 2018/19 to 1.1 in 2019/20. The malnutrition rate in the Cape Metro is however still the lowest amongst stall districts in the Western Cape and still considerably below the Provincial total of 1,6.

The national mortality rate (deaths per 1000 live births before 28 days of life) for the Cape Metro improved from 9.6 deaths in 2018/2019 to 8.9 in 2019/2020.The rate is on par with that of the Province (8.5).A total of 12.6 % of all babies born in facility in the city in 2019/20 weighed less than 25000grams.This compares favour notably to the Provincial total of 12.1 %.

9.6. Mental Health

The maternal mortality rate for the Cape Metro area, although improved substantially from 70.8 % in 2018/2019 to 57.9 % in 2019/2020, is still notably above the Provincial average of 48.0 %. The delivery rate to women under 19 years of age in the Cape Metro decreased ever so slightly from 9.6 in 2018/2019 to 9.5 in 2019/20.This is the

lowest teenaged pregnancy rate in the Western Cape. The termination of the pregnancy rate in the Cape Metro worsened from 1.1 % 2018/19 to 1.2 % in 2019/2020.this is the highest termination rate in the Province.

9.7. COVID-19

The City of Cape Town is one of the leading COVID-19 hotspots in the country and the Western Cape Province. The number of infections in the City started peaking earlier than anticipated towards the end of May 2020. As at 28 June 2020 the city reported a total number of infections of 45 856 with 4 001 infections reported in that week. During the same period, the City reported a total number of 277 deaths as a result of the COVID-19 pandemic. The dashboard below provides all the details.

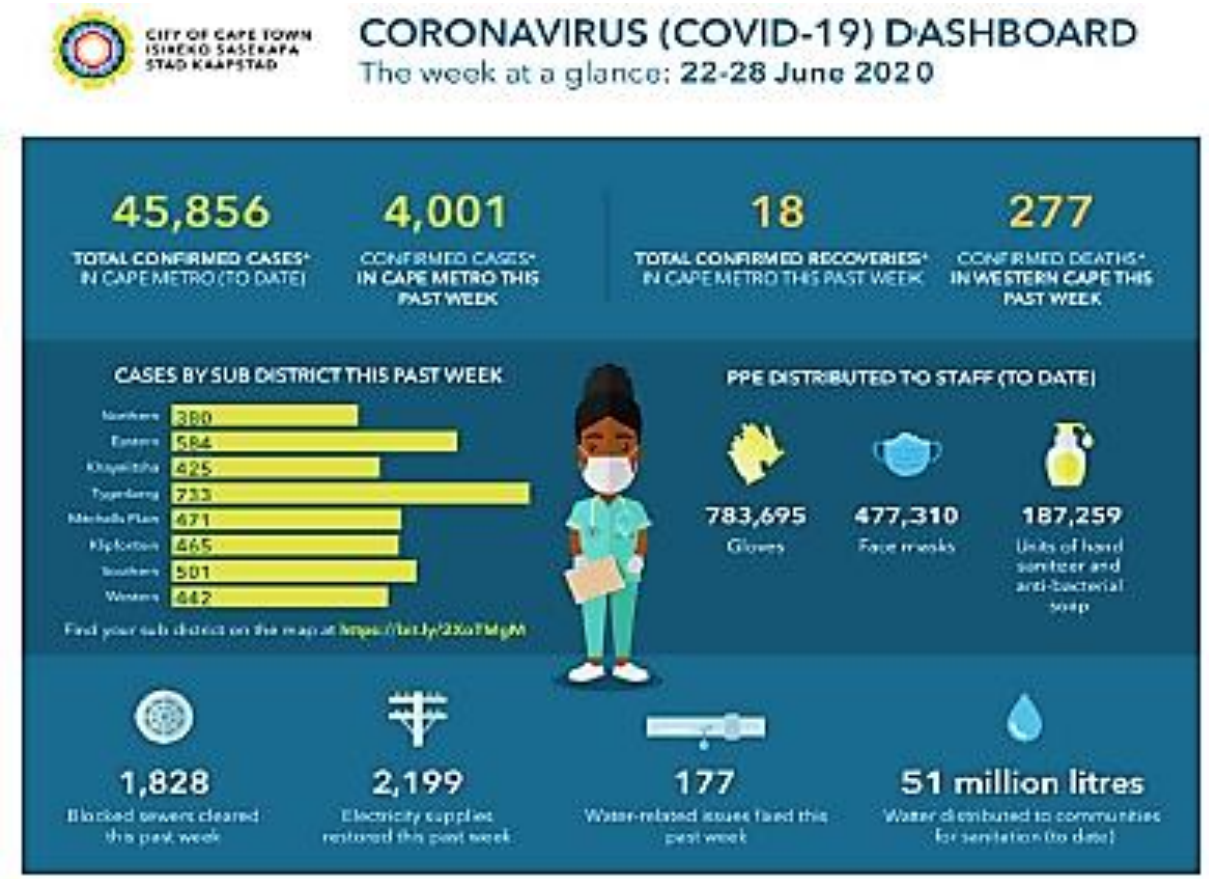


Figure 9-3: Corona Virus Cape Town Stats

The Council for Scientific and Industrial Research (CSIR) in collaboration with Albert Luthuli Centre for Responsible leadership developed a set of COVID-19 Vulnerability Indicators using available data. The Vulnerability Index identifies vulnerabilities present in communities and identifies areas in need of targeted coordinated interventions and early response. The purpose of the indicators is intended to support the early prevention/mitigation and preparedness phase of the disaster management cycle and informing disaster management decision making. The Index is not based on epidemiological modelling but a response that will highlight intervention areas due to

underlying situations. The composition of the index follows two main factors, namely: transmission potential and health susceptibility.

Transmission potential areas identifies areas that prevent social distancing to be practiced and were limitations of practicing good basic hygiene. The health susceptibility index denotes areas where large number of people are potential more susceptible to being adversely affected by COVID-10 due to factors such as age and underlying health conditions. The City of Cape Town vulnerability profile is presented in the map below. The map shows low vulnerability areas (blue dotted areas) versus areas with higher vulnerability (red dotted areas).

Consistent with vulnerability (including poverty and unemployment), limited access to healthcare, and population density, the following areas are most vulnerable and they are; Gugulethu, Kayelitsha, Mitchells Plain, Macasar and DuNoon. Most of these areas have been identified as hotspots in the sub-districts of the city as indicated in the table below.

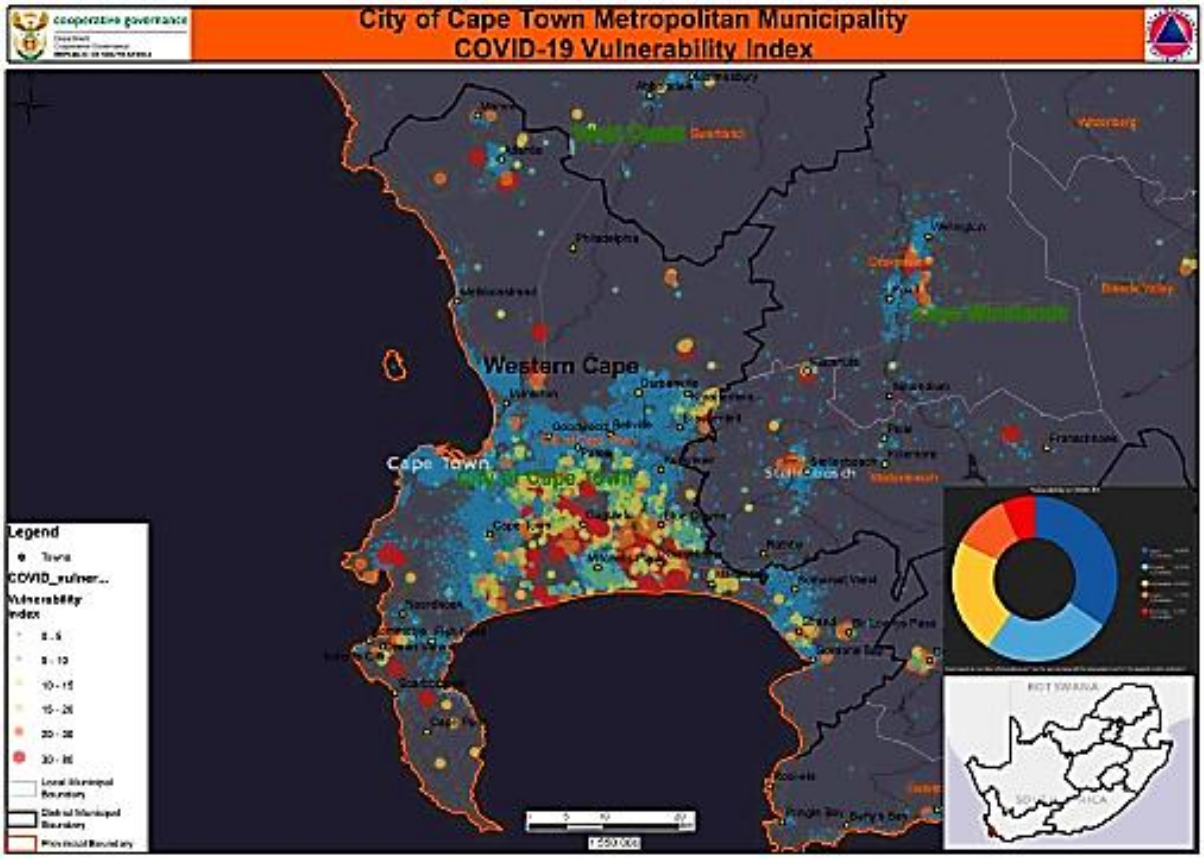


Figure 9-4: Vulnerability Index Map

The Vulnerability Index Map above, the table below shows a positive correlation on the hotspots that the City has identified in various sub-districts. The City of Cape Town created overflow facilities in their clinics. Certain services will be transferred from clinics to transfer facilities to facilitate social distancing and create the space required for healthcare of staff to manage COVID-19 cases. The Health Unit in the City is finalizing preparations for the first 20

overflow facilities in clinics. At the end of this project, at least 80 clinics will have been retrofitted in keeping with the COVID-19 preparedness plan. The overflow facilities are either prefabricated structures on clinic premises, or community halls in close proximity will be used. The first phase will result in 153 additional consulting and/or treatment spaces across the 20 clinics.

The figure below illustrates that majority of fatalities in the Western Cape are aged between 61 and 70 years of age.

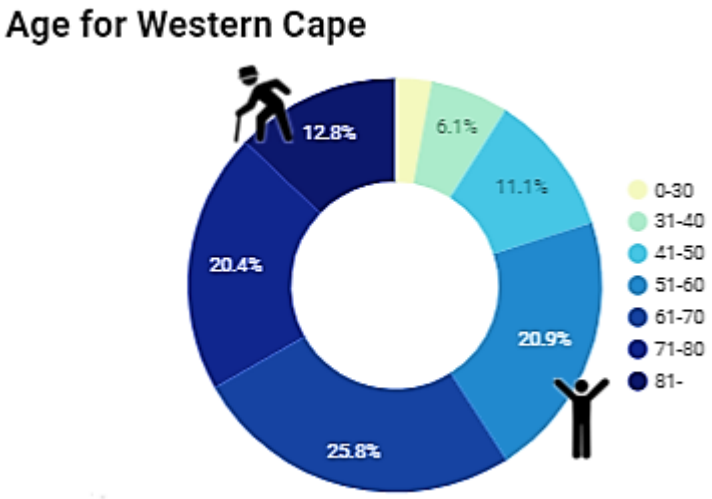


Figure 9-5: Fatalities in Cape Town Metropolitan Municipality

9.8. Safety and Security

Crime

The actual number of selected types of crime have been grouped into the 62 police precinct boundaries of the City of Cape Town. The City of Cape Town area has 62 police stations, including Samora Machel Police Station which is a new police station in the Nyanga cluster in Cape Town.

The following categories of crime: Violent Crimes, Property-related, Commercial crime and Drug- Related and Driving under the influence of alcohol or drugs are presented in the figure below. Violent, confrontational crimes include: murder, attempted murder, total sexual crimes (including rape and indecent assault), assault with intent to inflict grievous bodily harm (violent assault), common assault, robbery with aggravating circumstances (violent robbery) and public violence. The property-related crime refers to crimes in which property is stolen without the use of violence or force (i.e., no direct confrontation between perpetrators and victims), and includes the following crime categories: burglary at non-residential premises, burglary at residential premises, common robbery, theft of motor vehicle and motorcycle, theft out of or from motor vehicle and motorcycle, and all theft not mentioned elsewhere.

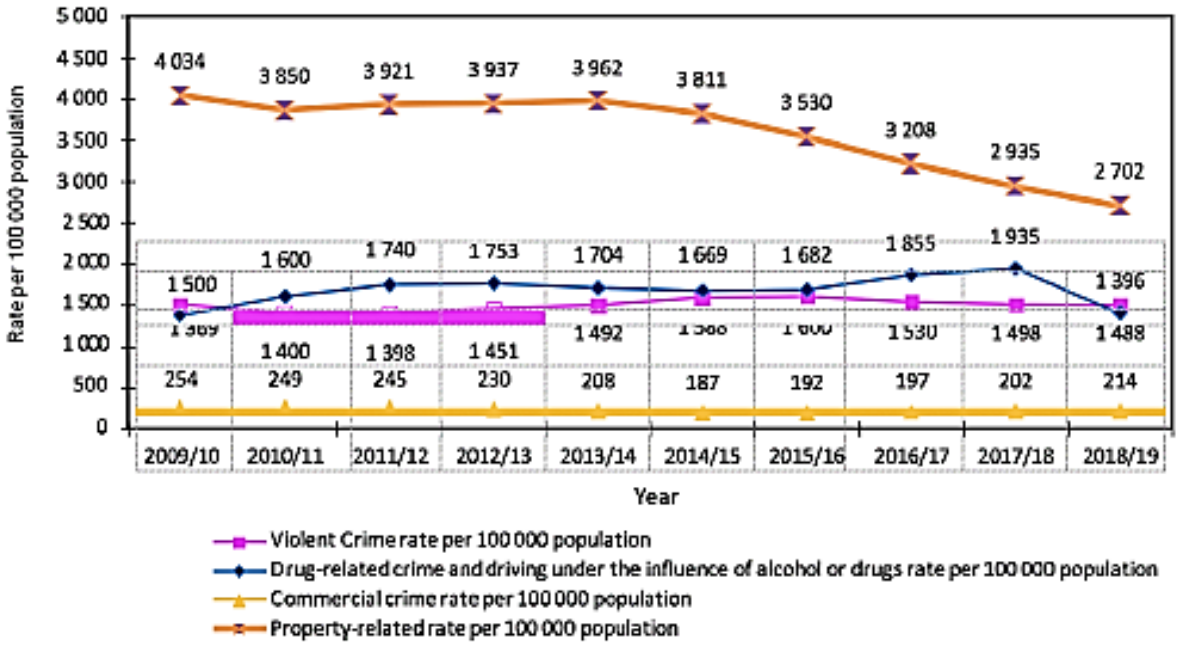


Figure 9-6: Crime statistics for the City of Cape Town between 2009 and 2019

The top 12 police precincts, accounted for over 40% of all reported crimes in Cape Town in 2018/19. The top five police precincts that account more than half of this (21.93%) were Cape Town Central (5.61%), Mitchells Plain (5.52%), Kraaifontein (3.88%), Delft (3.59%) and Nyanga (3.33%).

Murder

In the City, the murder of factual murders decreased from 314 in 2018/2019 to 308 in 2019/202. This amounted to a decrease in the murder rate from 70 occurrences per 100000 people to 67 (3.9 %). The City's murder ate was in 2019/2020 higher than any other municipal area in the province .in comparison, The murder rate for the province was 57 in 2019/2020.

Sexual Offences

The rate of sexual offences in South Africa is amongst the highest in the world. Sexual offenses in the city increased by 4.4 % from 92 occurrence per 100000 people in 2018/19 to 96 in 2019/20.This was the lowest sexual offences rates amongst the various district so of the Western Cape. Across the same period, the Western Cape sexual offences rate increased from 10 occurrences per 100000 people in 2019/20 to 104 in 2019/20

Drug-related Offences

Driving Under the Influence (DUI)

A total number of 7610 cases of driving under the influence (DUI) of alcohol or drug were registered in the City in 2019/20.Expressed per 100000 people, the DUI rate for the City was 165 occurrences in 2019/20. This total, which

amounts to a decrease of 10.2 % since 2018/19. Was lower than the Western Cape as whole (176) and also the second and lowest amongst all the other districts with 100 cases per 100000m people, the Cape Winelands District had the lowest DUI rate. The Central Karoo District had the highest DUI amongst the various district in 2019/20 with 323 occurrences. Road-user fatalities in the City increased from 740 in 2018/19 to 835 in 2019/20.

Residential Burglaries

Residential burglaries in the city decreased sharply between 2018/19 and 2019/20. In fact, a total of 2589 fewer burglaries were recorder in 2019/20. The burglary rate per 100000 people subsequently decreased by 13.7 % to 415 in 2019/20. This was the largest decline in residential burglaries amongst the various districts. For the Western Cape as whole the Burglary rate declined by 10.2 % to 515 occurrence per 100000 people.

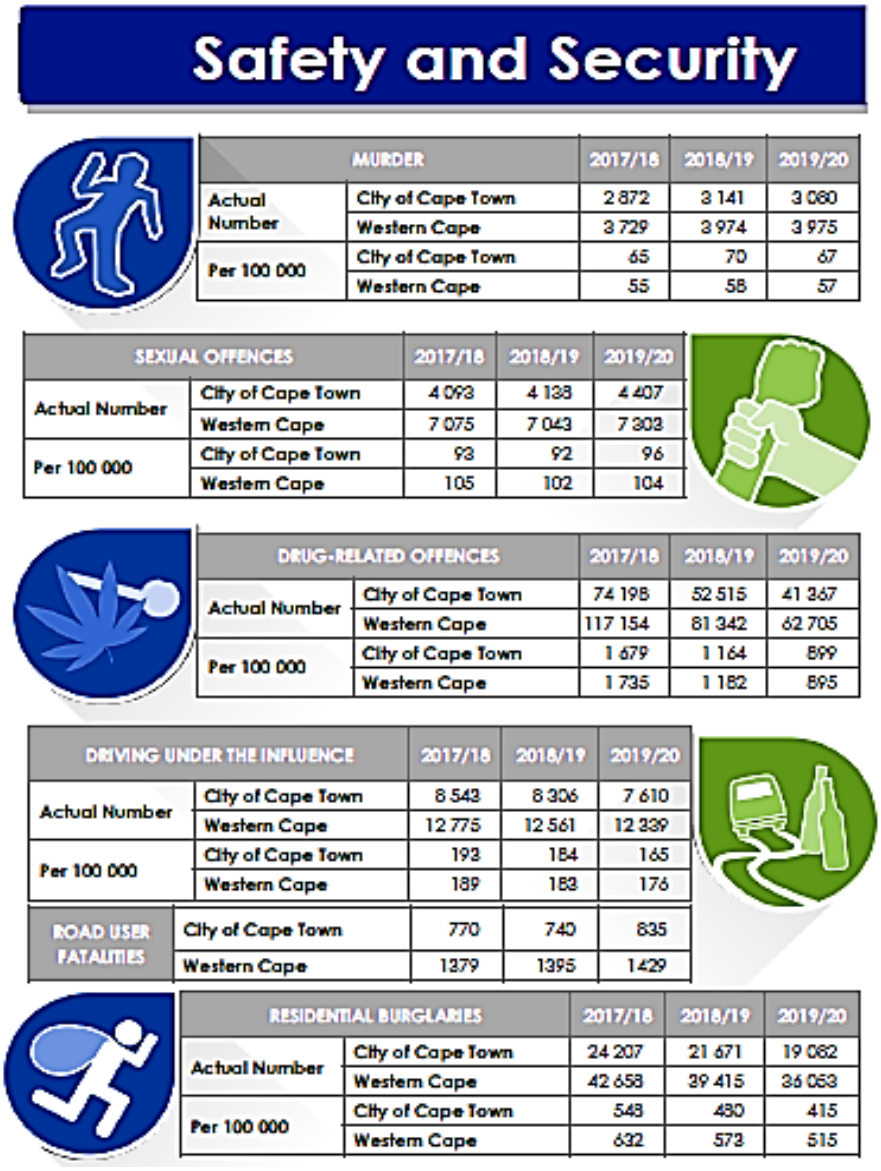


Figure 9-7: Cape Town Safety and Security Fact Sheet

9.9. Trends in leading causes of death by age

9.9.1. Under 5 Years

Preterm birth complications are the chief causes of death, followed by lower respiratory infections, diarrhoeal disease, sepsis/other new-born infectious, birth asphyxia, congenital heart anomalies, other perinatal conditions, diarrhoeal diseases, other respiratory (4 other congenital abnormalities and septicaemia being the least with 3.3%

9.9.2. 15–24 Years

Tuberculosis and HIV and AIDS remained the leading causes of death in this age group. Accidental threats to breathing replaced lower respiratory infections as the third leading cause of death, followed by interpersonal violence. Diarrhoeal diseases and road injuries both moved down one position, while mechanical forces moved up. Meningitis/ encephalitis remained the same, and epilepsy replaced drowning in 10th position.

9.9.3. 25–64 Years

Tuberculosis, HIV and AIDS accounted for over 45% of deaths in this age group, followed by lower respiratory infections, cerebrovascular disease and diarrhoeal diseases. Diabetes mellitus, hypertensive heart disease and asthma still featured in the top 10 causes of death, while meningitis/encephalitis dropped out and interpersonal violence moved in.

9.9.4. 65 years and older

Cerebrovascular disease, hypertensive heart disease, ischaemic heart disease, diabetes mellitus, lower respiratory infections and TB remained the leading causes of death. Asthma dropped from seventh to 10th position, while nephritis/ nephrosis, chronic obstructive pulmonary disease and diarrhoeal diseases all moved up.

10. Potential Human Health Impacts

Cremation is normally fuelled by gas (LPG for the Platinum Pride Project in particular) and will produce emissions associated with fossil fuel combustion as well as emissions related to the material being combusted. This can include:

- Combustion gases: carbon monoxide (CO), nitrogen oxides (NOx), sulphur dioxide (SO2) and volatile organic compounds (VOC);
- Particulate matter and fine dust: PM10 and $PM_{2.5}$;
- Organic pollutants: Compounds resulting from incomplete combustion processes or formed when organic compounds react with chlorine in materials such as plastics. These pollutants can include polychlorinated

dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) and polycyclic aromatic hydrocarbons (PAH) amongst others;

- Heavy metals: Mercury (Hg) arising from volatilization of Hg in dental amalgam in fillings and a small quantity of various metals in tissues of the individual, or personal memorial items included in the casket.

The pollutants of most concern are those known to be toxic to humans and which can bioaccumulate in tissues (e.g., PCDD/Fs and Hg) as well as fine particulate matter (PM2.5), which can negatively impact the heart and lungs and is associated with some chronic illnesses and adverse birth outcomes. Evidence on the release of radioactive particles, following cremation of deceased patients who had been treated with radioactive substances (e.g., cancer treatments) has not been widely studied but has been raised as an emerging area of public interest and concern.

Compared to other types of incineration facilities, such as municipal garbage incinerators or industrial operations, crematoria are typically regarded as small-scale installations with comparatively low overall emissions.

The relative contribution of each crematorium to local air pollution will vary depending on other potential sources of pollutants nearby, the quantity and kind of cremations, the makeup of the remains, the system's design, the cremator's operation, and emissions control measures.

Table 10-1: Factors affecting the level of possible emissions from crematoria

The composition of the casket and remains	• The initial combustion temperature, the time period (1.5 to 5) over which emissions are generated, and the overall amount of emissions are all influenced by the size of the corpse. • The presence of mercury (Hg)-containing dental amalgam fillings has an impact on 0.13 mercury emissions. Which may contain up to 0.5 g of mercury per filling, some of which may volatilize and be released into the environment. • The likelihood of fine particles and organic pollutants (such Polycyclic aromatic hydrocarbons (PAHs) and Polychlorinated Dibenzofurans PCDDs) forming in the combustion chamber can be increased by plastic or polystyrene components in the funeral coffin or personal or commemorative objects contained in the casket. • PCDD can be found in burial coffins that have been treated with pesticides or preservatives. Less hazardous compounds are released from caskets composed of untreated wood, cardboard, and similar materials • Low quantities of radiation or radioactive particles could be present in the combustion chamber due to the existence of radioactive materials in the remains, either from

The design of the system	• A cremator containing two combustion chambers enables high-temperature treatment of gases and particles, which lowers emitted odours, fine dust, and incomplete combustion products like PCDD. • The distribution and dilution of emissions into the atmosphere as well as their dispersion at ground level can be impacted by chimney height. • Older equipment may be more prone to failure as they are less likely to be equipped with modern process controls and monitors
Operational parameters of the cremator	• In the initial phases of cremation, low start-up temperatures may result in incomplete combustion, which can emit particles or products of incomplete combustion (PICs). • As well as ensuring there is enough oxygen for combustion, high temperatures (e.g., >850°C) and long residence times (2 s) for gases in the second chamber can minimize the amount of PICs emitted.
Emissions control measures	• Key pollutant emissions can be reduced through flue gas treatment, acid neutralization, activated carbon adsorption, dust collection, and good operation and maintenance procedures. • Emissions of fine particles and PCDD can be reduced by taking steps to minimize dust emission. • Equipment for lowering Hg emissions, such as activated carbon filters, scrubbers, and systems that bind or precipitate Hg, are effective in reducing mercury emission • It is less socially acceptable and more difficult to impose, but removing dental amalgams before cremation can remove mercury at the source in a way that is both economical and environmentally beneficial.

** Ikamva has committed to encourage the use of cardboard coffins to their client. This will help reduce hazardous emissions which would usually come from coffins and the metal hinges on it.

Table 10-2: Environmental Health Areas (EHAs)

Environmental Health Areas (EHAs)		
1	Vector-related diseases	Any facility at which organic waste is handled and/or treated has the potential to attract pests, including insects and vermin. The presence and concentration of pests is a factor of the design of the facilities, as well as the operation, management and maintenance of facilities. Climatic conditions also play a role in promoting or limiting pest proliferation. Rat populations thrive where there is human activity.
2	Acute respiratory infections and health impacts from crematoria emissions	PCDD, mercury, and fine particulate matter (PM2.5) are the contaminants from crematoria emissions that are of most concern when it comes to toxicity to human, as exposure to may reach deep into the lungs, can aggravate other illnesses like diabetes and raise the risk of heart disease, lung cancer, asthma, and affect pregnancies.
3	Veterinary medicine and zoonotic issues	No zoonotic issues were identified during literature research. It is however, important to remain cognizant that an increase in domestic animals may increase the risk for zoonotic diseases.
4	Sexually-transmitted infections, including Human Immunodeficiency Virus/ Acquired Immune Deficiency Syndrome (HIV/AIDS)	No anticipated impacts. Those infected with HIV are often infected with other organisms (such as mycobacteria), which may be more infectious (albeit less dangerous) than the HIV infection itself.
5	Soil-, water- and waste-related diseases	No anticipated impacts as no burial activities will take place. In addition to this, 287 litres per day will be used at the proposed Crematorium, which is far less than the 2.88kl per day. Chemicals will be used to clean the premises on site. The only contributors to the water demand will be the cleaning, washing of any food or vegetables, dishes etc. Again, this is anticipated to be minor. No water will be used in the process to clean internal machinery etc. all cleaning

		is done with brushes or hand, not with the use of water or chemicals. Industrial effluent is not anticipated.
6	Food- and nutrition-related issues	No anticipated impacts
7	Accidents/injuries	Work related accidents and injuries which can be avoided through the implantation of safe work procedures.
8	Exposure to potentially hazardous materials, noise and malodours	Studies have shown no relation between occupational exposure of dust mercury and radiation exposures and adverse health impacts. Exposure to fine particles may occur, especially when there are no operational or engineering controls to prevent exposure to dust, and exposure to mercury has been found to be higher among crematoria employees than in the general population.
9	Social determinants of health	Stress, depression and grieve
10	Cultural health practices	Roles of traditional medical providers, indigenous medicine ad unique health practice
11	Health systems issues	Physical health infrastructures and program management delivery systems
12	Non-communicable diseases	Cardiovascular diseases (like heart attacks and stroke), cancer, chronic respiratory diseases (such as chronic obstructed pulmonary disease and asthma) and diabetes.

10.1. EHA #8 Exposure to Potentially Hazardous Materials, Noise and Malodours

10.1.1. Noise

Noise is also a factor to consider and the health impacts of noise are well described at both a physical and psycho-social level in the Noise Impact Assessment. Noise is noted as potential environmental risks due to the nature of the Project's construction phase/ activities. The WHO published a set of guidelines relating to community noise, including potential sources, quantification and potential effects (WHO 1999). Potential health effects identified include hearing loss or loss of hearing sensitivity, sleep disturbance, cardiovascular and physiological effects, mental health effects and behavioural effects, including poor performance by school children (Stansfield and Matheson 2003, WHO 1999, Health Evidence Bulletins 1999). Environmental noise has also been found to be responsible for interference with communication, cognitive performance and annoyance (Stansfield and Matheson 2003, WHO 1999). Stansfield and Matheson (2003) concluded that the effects of environmental noise are strongest

for categories linked to quality of life (or the wider determinants of health in the context of HIA) as opposed to illness (or bio physical factors).

From an occupational health perspective, noise-induced hearing loss (NIHL) begins gradually and progressively gets worse. Problems with this disease include loss of the ability to communicate and reduced response to environmental and occupational noise and danger. Bise (2001) listed several factors that influence occupational hearing loss. These factors include the following:

- Age of employee.
- Pre-employment hearing impairment.
- Diseases of the ear.
- Sound pressure level of the noise.
- Length of daily exposure.
- Duration of employment.
- Ambient conditions of the workplace.
- Employee lifestyle outside the workplace.

The Combustion Air Fan is noise attenuated and located on top of the Cremator roof., thus the physical effect of hearing loss and impairment due to noise exposure is not a community health risk but is an important workplace occupational health consideration. The noise levels required to induce hearing loss only occur at levels above 85 dB(A) which would be intolerable for any community. Noise annoyance can however lead to stress-related impacts on health and general well-being and may also have an influence on mood, performance, fatigue and cognition. Sleep can be disturbed by noise levels as low as 35 dB(A).

10.1.2. Air Quality

The EMEP (European Monitoring and Evaluation Programme) and EEA (European Environment Agency) Air Pollutant Emission Inventory Guidebook (2009) includes a dedicated chapter on Cremation. The following information is taken from Chapter 6.C.d of the 2009 Guidebook. It is noted that no detailed information on cremation emissions is available for the Australian context, although emission is not expected to differ significantly across the world.

As mentioned earlier in this Report, the major emissions from crematories are nitrogen oxides, carbon monoxide, sulphur dioxide, particulate matter (TSP, PM10 and PM2.51), mercury, hydrogen fluoride (HF), hydrogen chloride (HCl), non-methane volatile organic compounds (NMVOCs), other heavy metals, and some Persistent Organic Pollutants (POPs). Emission rates depend on the design of the crematory, combustion temperature, gas retention time, duct design, duct temperature and any control devices. Particulates such as dust, soot, ash and other unburned particles originate from the cremation container, human remains, and other contents of the container.

Carbon-based organic particulates should be removed in the secondary combustion chamber and through proper adjustment and operation of the cremation equipment.

Mercury emissions originate from the dental fillings that may contain 5 to 10 grams of mercury depending on the numbers and types used. Mercury may be removed through the use of selenium salt in the cremation chamber (Hogland, 1994) or scrubbers. It should be noted that in some countries the use of plastic or other types of fillings are gaining popularity which will reduce the mercury emissions.

HF and HCl results from the combustion of plastics contained in the container and from stomach contents. These hydrogen compounds may be controlled through the use of wet scrubbers (Cremation Association of North America (CANA), 1993). NMVOCs are produced from incomplete or inefficient combustion of hydrocarbons contained in the fuels, body, and casket. NMVOCs are reduced through the proper use and adjustment of the crematory.

Dioxins and furans result from the combustion of wood cellulose, chlorinated plastics, and the correct temperature range. Dioxins and furans may be reduced through reduction in the chlorinated plastics and with sufficiently high temperature and residence time in the secondary combustion chamber. Reformation of dioxins and furans can be avoided by good design of the flue-gas ducts, by reducing particulate deposition and avoiding the dioxin and furan reformation temperature window.

Most contaminants (with the exception of heavy metals, HF and HCl) can be minimised through the proper operation of the crematory in conjunction with adequate temperature and residence time in the secondary combustion chamber. Heavy metals (with the exception of mercury) may be removed through particulate control devices. Emissions may be further reduced through the use of different types of containers such as fibreboard and cloth-covered fibreboard instead of the traditional finished wood.

The applicant has confirmed that LPG (Liquid Petroleum Gas), will be utilized as the main fuel source for the intended cremators, and considering the number of cremators planned to be accommodated, approximately 80m3 of LPG will be stored on site, when functioning at full capacity.

The surrounding land uses and zoning support industrial, commercial, utilities and business zones. The proposed Crematorium is not located within 500m radius of any zoned residential area, however, the Atmospheric Impact Assessment compiled by Yellow Tree (2022) advises that the Milnerton residential area is located 300 metres to the east of the proposed site and that the Milnerton Fire Station and Traffic Department is within 500m radius, with infrastructure similar to housing located to the north-west of the fire station. Considering the above the applicant may be required to request an exemption from the Local Government, in line with Chapter 2 (a), National Health Act, 2003 (Act No 61 of 2003), Regulations Relating to the Management of Human Remains, May 2013, based on the presence of habitable dwellings within approximately 400m radius of the site.

Pollutants that are emitted via a stack require sufficient dispersion and dilution in the atmosphere to ensure that they ground at concentrations that are deemed harmless. This is the basis upon which stack heights are calculated. As per the Atmospheric Impact Assessment conducted by Yellow Tree, the height of the 6 stacks will be 12m above ground level and approximately 6m above the nearby building. The AERMOD model was run (by Yellow Tree) using stack heights of up to 20 metres. The optimum height was determined to be 16 metres, which resulted in no NAAQS exceedances at the fence line for PM10 or NO2, unless these exceedances existed in the baseline data (i.e., daily PM10 in 2021 using the Edgemead baseline data). It is recommended that higher stack heights be considered by Ikamva to minimise the effect of the proposed crematorium on ambient air quality and, in relation, human health. The minimum combustion temperatures as provided by the furnaces manufacturer will be complied with before undertaking any cremation.

Local communities may already be exposed to low background levels of potentially hazardous materials (e.g., dust, particulate matter, heavy metals) that can be associated with health problems such as respiratory illnesses, skin diseases, organ damage, circulatory problems, birth defects, cancers and neurological disorders. As mentioned prior in this Report, air quality and odours have been addressed in detail in the Air Quality Report.

10.1.2.1 Types of Emissions

Cremation is a combustion process whereby a casket and human cadavers are incinerated at a high temperature in a closed chamber. Cremation is normally fuelled by gas and will produce emissions associated with fossil fuel combustion as well as emissions related to the material being combusted (Domingo, 2010). This can include:

- Combustion gases: carbon monoxide (CO), nitrogen oxides (NOx), sulphur dioxide (SO2) and volatile organic compounds (VOC);
- Particulate matter and fine dust: PM10 and $PM_{2.5}$;
- Organic pollutants: Compounds resulting from incomplete combustion processes or formed when organic compounds react with chlorine in materials such as plastics. These pollutants can include polychlorinated dibenzo-p-dioxins (PCDDs) and dibenzofurans (PCDFs) and polycyclic aromatic hydrocarbons (PAH) amongst others;
- Heavy metals: Mercury (Hg) arising from volatilization of Hg in dental amalgam in fillings and a small quantity of various metals in tissues of the individual, or personal memorial items included in the casket.

The pollutants of most concern are those known to be toxic to humans and which can bioaccumulate in tissues (e.g., PCDD/Fs and Hg) as well as fine particulate matter (PM2.5), which can negatively impact the heart and lungs and is associated with some chronic illnesses and adverse birth outcomes (NCCEH, 2020). Evidence on the release of radioactive particles, following cremation of deceased patients who had been treated with radioactive substances (e.g., cancer treatments) has not been widely studied but has been raised as an emerging area of public interest and concern.

10.1.2.2 Particulate Matter

Particles can be classified by their aerodynamic properties into coarse particles (2.5 – 10 µm), fine particles (<2.5 µm) and ultrafine particles (<0.1 µm). The coarse particles contain earth crust materials, fugitive dust from roads and industries, desiccated cellular debris, spores, and pollen. The fine particles contain combustion particles, the secondarily formed aerosols such as sulphates and nitrates, coagulation of ultrafine particles and recondensed organic and metal vapours. Ultrafine particles are produced mainly by combustion and contain organic carbon, refractory metals (added to or naturally present in fuels), and vapor condensation products (Phalen, 2004). In terms of health effects, particulate air pollution is associated with respiratory and cardiovascular morbidity, such as aggravation of asthma, respiratory symptoms, and an increase in hospital admissions. Inhalable particulate matter (PM) also leads to increased mortality from cardiovascular and respiratory diseases and from lung cancer

(WHO, 2013). Particle size is important for health because it controls where in the respiratory system a given particle deposits. Fine particles have been found to be more damaging to human health than coarse particles as larger particles are less respirable in that they do not penetrate deep into the lungs compared to smaller particles (Pope & Dockery, 2006). Larger particles are deposited into the extrathoracic part of the respiratory tract while smaller particles are deposited into the smaller airways leading to the respiratory bronchioles (WHO, 2005).

In the middle decades of the twentieth century, daily particulate concentrations in urban centres were in the range of 100 to 1000 µg/m3 (Fowler, et al., 2020) whereas in more recent times, daily concentrations are between 10 and 100 µg/m3. Overall, exposure-response can be described as curvilinear, with small absolute changes in exposure at the low end of the curve having similar effects on mortality to large absolute changes at the high end (WHO, 2000).

Short-term Exposure

There is good evidence that short-term exposure to particulate matter is associated with health effects (WHO, 2013). Studies suggest that short-term exposure to particulate matter leads to adverse health effects, even at low concentrations of exposure (below 100 µg/m3). Morbidity effects associated with short-term exposure to particulates include increases in lower respiratory symptoms, medication use and small reductions in lung function (Scapellato & Lotti, 2007). Susceptible groups with pre-existing lung or heart disease, as well as elderly people and children, are particularly vulnerable. For example, exposure to particulate matter affects lung development in children, including reversible deficits in lung function as well as chronically reduced lung growth rate and a deficit in long-term lung function (WHO, 2011). There is no evidence of a safe level of exposure or a threshold below which no adverse health effects occur (WHO, 2013)

Long-term Exposure

Long-term exposure to low concentrations (~10 µg/m3) of particulates is associated with mortality and other chronic effects such as increased rates of bronchitis and reduced lung function (WHO, 2005). Studies have indicated an association between lung function, chronic respiratory disease, and airborne particles. Relative risk estimates suggest an 11% increase in cough and bronchitis rates for each 10 µg/m3 increase in annual average particulate concentrations (WHO, 2000). Based on studies conducted in the USA, Europe and Canada, mortality is estimated to increase by 0.2–0.6% per 10 µg/m3 of PM10 (WHO, 2005; Samoli, et al., 2008). PM2.5 is a higher risk factor than the coarse part of PM10 (particles in the 2.5–10 µm range), particularly with long-term exposure. Long-term exposure to PM2.5 is associated with an increase in the long-term risk of cardiopulmonary mortality by 6–13% per 10 µg/m3 of PM2.5 (Pope, et al., 2002; Beelen, et al., 2008; Krewski, et al., 2009). Those most at risk include the elderly, individuals with pre-existing heart or lung disease, asthmatics, and children.

10.1.2.3 Health Impacts of PM: Cancer

Studies show an association between exposure to diesel exhaust and lung cancer (Bhatia, 1998), as well as cancers of the bladder and soft tissues (Guo et al., 2004). Several extensive and detailed reviews have been conducted on the body of literature relating long-term exposure to diesel exhaust particles and lung cancer (California EPA, 1998; USEPA, 2002; Cohen and Nikula, 1999). In addition, over forty studies conducted among those populations exposed to diesel exhaust have found increased rates of lung cancer associated with diesel exhaust particles exposure (as cited in Cohen and Nikula, 1999). Occupational studies conducted in railroad workers and truck drivers have consistently found increased lung cancer risk, even after adjusting for comorbidities such as smoking (Bofetta, 2001).

10.1.2.4 Health Impacts of PM: Cardiac and Pulmonary

Although cancer risk is understandably of great concern to the public, cardiac and respiratory effects of diesel exposure have an even larger public health impact because they cause death and illness for a greater number of people. PM can exacerbate asthma and emphysema, induce heart attacks and strokes, and has been associated with congenital heart abnormalities. According to a landmark study by Pope et al (2002), each 10 ug/m3 increase in PM was associated with a 6% increase in cardiopulmonary mortality. In a follow-up to this study, Pope et al (2004) demonstrated that their previously observed increase in cardiopulmonary mortality was largely driven by increases in cardiovascular, as opposed to pulmonary mortality. In this follow-up study, a 10 ug/m3 increase in PM2.5 was associated with a 12% increase in mortality due to 'all cardiovascular disease plus diabetes' and an 18% increase in mortality due to 'ischemic heart disease'. Further epidemiological investigations have revealed that these estimates are likely largely underestimating the effect of $PM_{2.5}$ due to inadequate exposure characterization. Published in the New England Journal of Medicine, Miller et al. (2007) utilized a novel exposure

characterization method and reported from the Women's Health Study that a 10 ug/m3 increase in $PM_{2.5}$ was associated with a 76% increase in death due to cardiovascular disease.

It is well understood that ambient air pollution and fine ambient particulate matter strongly contribute to disease burden and death, but it has been less clear as to how much an individual's living proximity to a major roadway or direct PM2.5 source influences health risks. An individual's exposure to $PM_{2.5}$ is dependent on where he/she lives and works and that this strongly influences health outcomes. Van Hee et al. (2009) demonstrated that living close to a major roadway was a strongly associated with left ventricular hypertrophy, an important marker of cardiovascular disease and a strong predictor of heart failure and mortality. Additional work by this group has demonstrated an individual's exposure to PM2.5 impairs how well blood vessels dilate and how well the heart functions, providing a basis for our understanding of previously observed increases in mortality (Van Hee et al. 2011, Krishnan et al. 2012).

There are very specific physiological effects with PM exposure. A recent study by Cosselman et al (2012) showed that diesel exhaust exposure, to healthy human volunteers, rapidly increases systolic blood pressure (SBP). In their study, SBP increased within 15 minutes of being exposed to dilute diesel exhaust and reached a maximum increase in SBP within one hour. Additional work utilising controlled diesel exhaust exposures to human volunteers has revealed that these acute exposures result in impairment in blood vessel function and alters blood coagulability[3], both of which are extremely deleterious effects and increase the risk of acute cardiovascular events such as heart attack and stroke (Mills et al. 2005, 2007, and Törnqvist et al. 2007). Fitting with these findings, epidemiological investigations have consistently demonstrated that acute increases in $PM_{2.5}$ result in an increased risk of heart attack (Peters et al. 2001).

In addition to cardiovascular risk, cerebrovascular effects and risk of stroke associated with $PM_{2.5}$ exposure has been investigated. Research published in the Archives of Internal Medicine (2012) examines, for the first time, the risk of acute, short-term exposures to $PM_{2.5}$ as a key factor in triggering stroke, often within hours of exposure.

Table 10-3: Short-term and long-term health effects associated with exposure to PM (after WHO, 2000).

Pollutant	Short-term exposure	Long-term exposure
Particulate matter	• Lung inflammatory reactions • Respiratory symptoms • Adverse effects on the cardiovascular system • Increase in medication usage • Increase in hospital admissions	• Increase in lower respiratory symptoms • Reduction in lung function in children • Increase in chronic obstructive pulmonary disease

[3] Coagulation (also known as clotting) is the process by which blood changes from a liquid to a gel, forming a blood clot. It potentially results in haemostasis, the cessation of blood loss from a damaged vessel, followed by repair.

Pollutant	Short-term exposure	Long-term exposure
	Increase in mortality	Reduction in lung function in adults Reduction in life expectancy Reduction in lung function development

10.1.2.5 Sulphur Oxide

SO_2 originates from the combustion of sulphur-containing fossil fuels in applications such as residential heating, industries, stationary power generation, ships and motor vehicles, and is a major air pollutant in many parts of the world. Health effects associated with exposure to SO_2 are mainly associated with the respiratory system. Being soluble, SO_2 is readily absorbed in the mucous membranes of the nose and upper respiratory tract (Witschi & Last, 2001).

Short-term exposure

The effects of short-term exposure to SO_2 include reductions in ventilatory capacity, increases in specific airway resistance, and symptoms such as wheezing or shortness of breath (WHO, 2005). Most information on the acute effects of SO_2 is derived from short-term exposure in controlled chamber experiments. These experiments have demonstrated a wide range of sensitivity amongst individuals. Acute exposure of SO_2 concentrations can lead to severe bronchoconstriction in some individuals, while others remain completely unaffected. Response to SO_2 inhalation is rapid with the maximum effect experienced within a few minutes. Continued exposure does not increase the response. The effects are, however, increased by exercise that increases the amount and depth of inhalation, and breathing through the mouth. Effects of SO_2 exposure are short-lived with lung function returning to normal within a few minutes to hours (WHO, 2000; WHO, 2005).

Exposure over 24 hours

The effects of exposure to SO_2, averaged over a 24-hour period, are derived from epidemiological studies in which the effects of SO_2, particulates and other associated pollutants are assessed. Studies of the health impact of emissions from the inefficient burning of coal in domestic appliances have shown that when SO_2 concentrations exceed 250 µg/m^3 in the presence of particulate matter (as sulphates), an exacerbation of symptoms are observed in selected sensitive patients. More recent studies of health impacts in ambient air polluted by industrial and vehicular activities have demonstrated, at low levels, effects on mortality (total, cardiovascular and respiratory) and increases in hospital admissions. In these studies, no obvious SO_2 threshold level was identified (WHO, 2005).

Long-term exposure

Long-term exposure to SO_2 has been found to be associated with an exacerbation of respiratory symptoms and a small reduction in lung function in children in some cases. In adults, respiratory symptoms such as wheezing, and coughing are increased. The Hong Kong "intervention" study (Hedley, et al., 2002) indicated significant health benefits, both immediate and long-term, in reducing SO_2 from a daily average of 44 µg/m^3 to 21 µg/m^3.

10.1.2.6 Nitrogen Oxide

Nitric oxide (NO) is a primary pollutant emitted from combustion at stationary sources (heating, power generation, industrial incinerations) and from motor vehicles. Nitrogen dioxide (NO_2) is formed through the oxidation of nitric oxide. Oxidation of NO by O_3 occurs rapidly, even at low levels of reactants present in the atmosphere. As a result, this reaction is regarded as the most important route for nitrogen dioxide production in the atmosphere. Health effects of NO_2 gas are related to its ability to dissolve in the moisture on any moist tissue surfaces to form nitric acid which can burn delicate tissues. As such, NO_2 is an irritant asphyxiant gas which can produce severe irritation in the air passages and lungs (Queensland Government, 2017).

Nitrogen dioxide is an important gas, not only because of its health effects, but because it (a) absorbs visible solar radiation and contributes to visibility impairment, (b) could have a potential role in global climate change if concentrations were to increase significantly, (c) is a chief regulator of the oxidizing capacity of the free troposphere by controlling the build-up and fate of radical species, including hydroxyl radicals and (d) plays a critical role in determining ozone concentrations.

Short-term exposure

Experimental toxicology indicates that nitrogen dioxide is a toxic gas (in short-term concentrations exceeding 200 µg/m^3) with significant health effects (WHO, 2005). However, short-term concentrations of NO_2 greater than 1 880 µg/m^3 (i.e., concentrations which are higher than those normally found in ambient air) are required to bring about changes in the pulmonary function of healthy adults (WHO, 2000). Normal healthy people exposed at rest or with light exercise for less than 2 hours to concentrations above 4 700 µg/m^3 (2 500 ppb), experience pronounced decreases in pulmonary function. Asthmatics are potentially the most sensitive subjects although various studies of the health effects on asthmatics have been inconclusive. The lowest concentration causing effects on pulmonary function was reported from two laboratories that exposed mild asthmatics for 30 – 110 minutes to 565 µg/m^3 (301 ppb) during intermittent exercise (WHO, 2005)

Long-term exposure

Animal studies have shown that exposure to 1 880 µg/m^3 over a period of several weeks to months, causes effects in the lungs and other organs such as the spleen and liver. Structural changes include a change in cell type in the tracheo-bronchial and pulmonary regions to emphysema-like effects. NO_2 concentrations as low as 940 µg/m^3, can also increase the lung's susceptibility to bacterial and viral infections (WHO, 2000). It is known that these toxic

effects of NO_2 might occur in humans, but because of differences in species sensitivity, the effects that are caused by a specific inhaled concentration of NO_2 cannot be deduced with any level of confidence (WHO, 2005).

It is very difficult to differentiate the effects of nitrogen dioxide from those of other pollutants in outdoor epidemiological studies. This is because the complex gas-particle mixture of NO_2, organic and elemental carbon, inorganic acids, $PM_{2.5}$ and ultrafine particles all usually come from the same combustion sources (WHO, 2005).

Epidemiological studies have been undertaken on the indoor use of gas cooking appliances and health effects. Studies on adults and children under 2 years of age found no association between the use of gas cooking appliances and respiratory effects. Children aged 5 – 12 years have a 20% increased risk for respiratory symptoms and disease for each increase of 28 µg/m^3 (15 ppb) NO_2 concentration, where the weekly average concentrations are in the range of 15 – 128 µg/m^3 (8 – 68 ppb) (WHO, 2005).

Outdoor studies consistently indicate that children with long-term ambient NO_2 exposures exhibit increased respiratory symptoms that are of a longer duration. However, no evidence is provided for the association of long-term exposures with health effects in adults (WHO, 2005).

10.1.2.7 Ozone

Ozone in the atmosphere is a secondary pollutant formed through a complex series of photochemical reactions between NO_2 and VOCs in the presence of sunlight. Sources of these precursor pollutants include motor vehicles and industries. Atmospheric background concentrations are derived from both natural and anthropogenic sources. Natural concentrations of O_3 vary with altitude and seasonal variations (i.e., summer conditions favour O_3 formation due to increased insolation). Diurnal patterns of O_3 vary according to location, depending on the balance of factors affecting its formation, transport, and destruction. From the minimal levels recorded in the early morning, concentrations increase because of photochemical processes and peak in the afternoon. During the night, O_3 is scavenged by nitric oxide. Seasonal variations in O_3 concentrations also occur and are caused by changes in meteorological conditions and insolation. Quarterly mean (arithmetic average of daily values for a calendar quarter) O_3 concentrations are typically highest in summer (WHO, 2005).

Ozone is a powerful oxidant and can react with a wide range of cellular components and biological materials. Health effects and the extent of the damage associated with O_3 exposure is dependent on O_3 concentrations, exposure duration, exposure pattern and ventilation (WHO, 2005)

Short-term exposure

Short-term effects include respiratory symptoms, pulmonary function changes, increased airway responsiveness and inflammation. Field studies in vulnerable persons (children, adolescents, young adults, elderly, and asthmatics) have indicated that pulmonary function decrements can occur because of short-term exposure to O_3 concentrations

in the range 120 – 240 µg/m^3 (61 – 122 ppb) and higher. Ozone exposure has also been reported to be associated with increased hospital admissions for respiratory causes and exacerbation of asthma (WHO, 2005).

Long-term exposure

There is limited information linking long-term O_3 exposure to chronic health effects, however, there are suggestions that cumulative O_3 exposures may be linked with increasing asthma severity and the possibility of increased risk of becoming asthmatic (Katsouyanni, 2003).

Evidence provided by studies of health effects related to chronic ambient O_3 exposure is consistent in indicating chronic effects on the lung. Some studies have shown that long-term exposure to concentrations of O_3 in the range 240 – 500 µg/m^3 (122 – 255 ppb) causes morphological changes in the region of the lung resulting in a reduction in lung function (Katsouyanni, 2003).

10.1.2.8 Carbon Monoxide

Carbon monoxide (CO) is one of the most common and widely distributed air pollutants. CO is a tasteless, odourless, and colourless gas, which has a low solubility in water. In the human body, after reaching the lungs it diffuses rapidly across the alveolar and capillary membranes and binds reversibly with the haem proteins. Approximately 80 – 90% of CO binds to haemoglobin to form carboxyhaemoglobin which is a specific biomarker of exposure in blood. The affinity of haemoglobin for CO is 200 – 250 times that for oxygen. This causes a reduction in the oxygen-carrying capacity of the blood which leads to hypoxia as the body is starved of oxygen.

Anthropogenic emissions of CO originate from the incomplete combustion of carbonaceous materials. The largest proportion of these emissions is produced from exhausts of internal combustion engines, in particular petrol vehicles. Other sources include industrial processes, coal power plants and waste incinerators. Ambient CO concentrations in urban areas depend on the density of vehicles and are influenced by topography and weather conditions. In the streets, CO concentrations vary according to the distance from the traffic. In general, the concentration is highest at the leeward side of the ‘street canyon’ with a sharp decline in concentration from pavement to rooftop level (Schwela, 2000).

Short and Long-term exposure

The adverse health effects of CO vary, depending on the concentration and time of exposure. Clinical symptoms range from headaches, nausea and vomiting, muscular weakness, and shortness of breath at low concentrations (10 ppm) to loss of consciousness and death after prolonged exposure or after acute exposure to high CO concentrations (>500 ppm). Poisoning may cause both reversible, short-lasting neurological deficits and severe, often delayed, neurological damage. Neuro-behavioural effects include impaired co-ordination, tracking, driving ability, vigilance, and cognitive ability at carboxyhaemoglobin levels as low as 1.5 – 8.2% (WHO, 2005).

High risk patients with regards to CO exposure include persons with cardiovascular diseases (especially ischaemic heart disease), pregnant mothers and the foetus and new-born infants. Epidemiological and clinical studies indicate that CO from smoking and environmental or occupational exposures may contribute to cardiovascular mortality (WHO, 2005).

10.1.2.9 Benzene

Benzene is a volatile organic compound (VOC). VOCs are organic chemicals that easily vaporise at room temperature and are colourless. Benzene in air exists predominantly in the vapour phase, with residence times varying between a few hours and a few days, depending on the environment, climate, and the concentration of other pollutants. The only benzene reaction, which is important in the lower atmosphere, is the reaction with hydroxy radicals. The products of this reaction are phenols and aldehydes, which react quickly and are removed from the air by rain.

Benzene is a natural component of crude oil, and petrol contains 1 – 5% by volume. Benzene is produced in large quantities from petroleum sources and is used in the chemical synthesis of ethyl benzene, phenol, cyclohexane, and other substituted aromatic hydrocarbons. Benzene is emitted from industrial sources as well as from combustion sources such as motor engines, wood combustion and stationary fossil fuel combustion. The major source is exhaust emissions and evaporation losses from motor vehicles and during the handling, distribution, and storage of petrol.

Information on health effects from short-term exposure to benzene is fairly limited. The most significant adverse effects from prolonged exposure to benzene are haematotoxicity, genotoxicity and carcinogenicity. Chronic benzene exposure can result in bone marrow depression expressed as leukopenia, anaemia and/or thrombocytopenia, leading to pancytopenia and aplastic anaemia. Based on this evidence, C_6H_6 is recognized to be a human and animal carcinogen. An increased mortality from leukemia has been demonstrated in workers occupationally exposed (WHO, 2005).

Considering that the proposed crematorium is to be located in a large industrial area, the proposed site is surrounded by a number of contributors to air pollution, including Astron Energy, Permoseal, BP, Engen, Cape Precious Metals, Gayatri Paper and Novus Printing works (Yellow Tree, 2022). The contribution of these sources to air pollution was taken into account when the cumulative impact of the proposed crematorium on air quality was assessed by Yellow Tree. This is because the baseline data that is used in this assessment already reflects the effect of the existing contributors to air pollution in the area. The ambient pollutant concentrations that were predicted by the AERMOD model were added to baseline air quality data to obtain cumulative predicted concentrations. These findings have been presented in the AQIA by Yellow Tree (2022). Whilst reading this study, one needs to remain cognizant that the cumulative results are based on the extremely conservative assumption

that the maximum hourly concentration is to be experienced every hour in the three-year period, which would not occur in reality.

10.1.3. Mercury

Mercury occurs in the environment as a result of natural processes (e.g., volcanic outgassing) and human activities like mining and burning of fossil fuels

Metallic (elemental) mercury, inorganic compounds, and organic compounds are the three different types of mercury that can be found in the environment. One of the biggest public health concerns is exposure to mercury and its compounds. The degree of toxicity varies according on the types of mercury, exposure levels, and exposure routes (Piagno & Afshari, 2020). Dental amalgam also contains elemental mercury, which contributes to its beneficial qualities and makes up around 50% of the amalgam mixture.

A quantitative assessment of human health risks associated with exposure to mercury vapour emitted from crematoriums in BC was undertaken according to the standard paradigm established by the US National Research Council (NRC) (National Research Council 1983) and endorsed by both the US EPA and Health Canada: problem formulation, hazard identification, dose-response assessment, exposure assessment, and risk characterization. Given the limited public availability of detailed specifications for crematoriums in the province, the analysis was conducted for a generic facility with cremation gas properties and stack specifications typical of the industry, based on a cursory review of publicly available permits and approvals for facilities located outside BC.

Problem formulation Part A of the analysis assessed the risk to human health associated with chronic inhalation exposure to mercury vapour at the maximum estimated long-term average 24-h period ground-level concentration resulting from crematorium emissions. In part B, we evaluated the maximum estimated short-term average ground-level mercury vapour concentrations against short-term exposure limits. In both cases, risk was assessed at the individual receptor level, with the receptor positioned at ground level and continuously exposed.

Hazard characterization in humans, chronic inhalation exposure to elemental mercury vapour at subacute concentrations may adversely affect the central nervous system resulting in, for example, increased excitability, irritability, excessive shyness, and tremors (Mercury n.d.). Chronic, subacute exposure to mercury vapour may also induce psychotic reactions (Friberg 1991). In exposed workers, a range of clinical effects are reported at a concentration of 0.79 mg/m3 (for over 1.5 years), 0.9 mg/m3 (for over 5 years), and 0.014–0.076 mg/m3 (for over 15 years). Elemental mercury is not currently classified as a human carcinogen due to inadequate evidence of carcinogenicity, so this assessment exclusively focuses on non-cancer endpoints.

The results of this Study suggest that ground-level exposure to elemental mercury vapour emitted from crematoriums in BC does not pose a significant risk to human health at the individual receptor level. This is contrary to public perception, but agrees with the findings of similar analyses described in the literature, for example in Green et al. from the USA (Green et al. 2014). In summary, literature focussing on the risk assessment of mercury

and crematoriums found no indication that ground-level exposures to elemental mercury vapour from crematoriums poses a significant risk to human health.

10.1.3.1. Health Impacts of Mercury

At higher concentrations, mercury vapour can cause damage to the mouth, respiratory tract and lungs, and can lead to death from respiratory failure. Long-term exposure to low concentrations causes symptoms similar to those of methyl mercury. Acute exposure to high concentrations of elemental mercury vapour, such as workers who were exposed to 0.79 mg/m3 for 1.5 years, 0.9 mg/m3 for over 5 years, and 0.014–0.076 mg/m3 for over 15 years, or in cases that are exposed for a longer period such as in occupational settings, may be followed by chest pains, dyspnea, coughing, hemoptysis, and sometimes interstitial pneumonitis leading to death (Piagno & Afshari, 2020).

Due to the long-term low-dose exposure, crematoriums are sources of air pollution, particularly mercury emissions, which have the potential to have subtle, chronic health consequences. From a health standpoint, describing the type and intensity of the evidence of causation and dose-response evaluation are required

It has been found that mercury emissions from crematoriums account for an insignificant percentage of the total emissions in the atmosphere. A risk assessment revealed no evidence that ground-level exposure to elemental mercury vapour from crematoriums posed a serious danger to human health (Piagno & Afshari, 2020).

10.1.3.1.1. Health Impacts Associated with the Handling and Storage of Cadavers

Cadavers may pose hazards to those handling them. The recently dead may have been infected by a wide range of pathogens. Infectious pathogens in cadavers that present particular risks include Mycobacterium tuberculosis[4], hepatitis B and C, the AIDS virus HIV, and prions that cause transmissible spongiform encephalopathies such as Creutzfeldt-Jakob disease (CJD) and Gerstmann-Straussler-Scheinker syndrome (GSS) (Weed and Baggenstoss, 1951; Brown et al., 1986; Roth et al., 1992; De Craemer, 1994; Healing et al., 1995; Kappel et al., 1996; Catteneo et al., 1999). It is often claimed that fixatives are effective in inactivation of these agents (Demiryürek, 2002). Literature suggests that, cadavers, even though they are fixed, may still pose infection hazards to those who handle them.

Although most of the microorganisms that cause death do not survive for long after the host dies or are not readily transmissible in that context. Soft tissues remaining on a human cadaver could present an infection risk. In most circumstances, the infected living is a greater hazard than are the dead, even those who have died of infectious disease. Whilst a person is alive, invading pathogens can multiply and are readily transmitted; the patient is a

[4] Tuberculosis: Opening human cadavers of individuals infected with tuberculosis is dangerous and workers in morbid anatomy, pathologists, mortuary technicians, and medical students have a comparatively high rate of tuberculin conversion. Crematorium workers will not be opening up cadavers therefore the risk of being infected is negligible.

continuing source of infection (Hoffman, 2022). Once the host is dead, most pathogenic microorganisms cease multiplying and die rapidly as a result of microbial competition as the body decomposes.

In general, standard infection prevention practice, the use of appropriate protective clothing, will greatly reduce the risk of acquiring infection, but some additional precautions may be advisable for particular infections, for example, when dealing with infectious agents transmitted by a vector that is resident on the deceased (e.g., body lice), as these will leave the deceased and may move onto those handling the cadaver putting them at risk (*ibid*.).

Hepatitis A is transmitted by the faecal-oral route and presents the same hazard as other gastrointestinal pathogens. A highly effective vaccine is available. A highly effective vaccine is available and staff working in hospital mortuaries, crematoriums and embalmers should routinely receive immunisation against this infection. The bodies of those who have died of, or were known to be infected with, this virus should be handled only by those wearing full protective clothing as wounds and other sites of virus escape from bodies may not be apparent when starting a procedure (*ibid*.).

The routes of transmission of hepatitis B and of HIV are similar and the precautions required to prevent the transmission of the former should be adequate to prevent transmission of the latter. HIV is less infectious than hepatitis B and the risk to those handling infected human cadavers is therefore proportionately less. HIV can survive for many days post-mortem in tissues preserved under laboratory conditions. Care should be taken when handling unfixed, HIV-infected material from human cadavers, or when undertaking post-mortem examinations on those infected with HIV (*ibid*.).

The risk of infection hazards of human cadavers can be greatly reduced by:

- Covering cuts or lesions with waterproof dressings;
- Careful cleansing of any injuries sustained during procedures;
- Wear single-use gloves and impervious single-use aprons;
- Take care not to contaminate their instruments or their working environment;
- Wash their hands carefully after touching the cadaver(s) and before eating, drinking, or smoking;
- Good personal hygiene; and
- Use of appropriate protective clothing

10.1.3.2. SARS-CoV-2 (COVID-19)

The normal route of transmission of SARS-CoV-2 is via respiratory droplets and aerosols, with the bronchial and conjunctival epithelia as the probable main points of entry. The virus can affect many organs of the body and persist for long periods in infected individuals. SARS-CoV-2 can remain viable on inanimate surfaces for up to nine days under laboratory conditions (CDC, 2020), but the importance of such contamination as a source of infection remains unclear. With regards to preparation for burial or cremation of those who have died of SARS-CoV2

infection, the bereaved are advised to avoid rituals or practices that bring them into close contact with the deceased. If religious observance requires such contact (for example viewing, embalming, cosmetic enhancement or hygienic preparation) it should be limited to those who are wearing PPE, under the supervision of someone who is trained in the appropriate selection and use of PPE.

Guidance on the safe handling of those who have died with or from SARS-CoV-2 infection, including full autopsy procedures and the collection of specimens from cadavers, is available from several national and international sources and those dealing with such individuals are advised to follow the guidelines most relevant to their location.

10.1.4. Odour

An odour can be due to a single chemical species in the air; it can be due to a dominant odorous chemical species among many other essentially non-odorous substances; or it may be a mixture of several or many substances, some or all of which may be odorous. Some odours are more unpleasant than others and have more potential to cause offence or nuisance (DEFRA, 2006).

Although unlikely, foul odour may be emitted at the crematorium due to continuous incineration of organic matter. The problem is intensified if proper mitigation measures are not adopted. Odour is also emitted at the collection points if quick removal of wastes is not practised.

Odour nuisance may be mitigated through the use of a separation distance between the odour source and residential areas. According to Schauberger *et al*. (2012), different governments have different rules and ordinances, yet there is a current global trend showing the implementation of major community involvement, individually and as a whole, in regulatory steps. This trend can be seen in regulations being proposed and promulgated in Europe, Australia, and North America (Frechen, 2003). The determination of the buffer area is necessary in many situations to avoid or minimise the potential for land use conflict. While not replacing the need for best practice approaches to emission management, the use of buffers is a useful tool in achieving an acceptable environmental outcome (Moja and Mnguni, 2014).

Control of odours from the source was identified as an important option for solving odour problems which should involve discovering the source, measuring the odour emissions and identifying the component odorous compounds. Odour control measures at crematoriums should include containment strategies (such as physical, biological and chemical treatment of captured odorous gases), influencing process conditions and application during the cremation process.

Management and control measure of odour emissions and contaminants in crematorium may be reduced and / or eliminated through installation of ventilators and exhaust fans, considering practical conditions, such that low-concentration odour emissions can be promptly diluted and discharged. Furthermore, equipment will be operated in an intermittent working mode to reduce odour accumulation at the crematorium and fence line.

Commonly used method for lowering odour emission levels is dilution. Dilution achieves odour reduction by passing the flue gas through a secondary combustion chamber, in which the odour generated in the main combustion chamber is burned again at a high temperature to generate CO, carbon dioxide, NOx, etc., while fresh air is blown through to dilute the odour. It is recommended that this method may be employed to further reduce odour at the crematorium.

Sakawi *et al*. (2011) indicated that weather is one of the environmental components which influence the frequency and the intensity of odour perceived by sensitive receivers. The influence of weather such as wind direction and wind speed, temperature and rainfall can all affect the concentration of odour from the crematorium. Odour, however, is not expected to be a considerable nuisance for the proposed crematorium.

Research shows that in a modern effectively functioning crematorium, after it all, there is nothing left to smell -little to no odour. The heat is high enough that everything that can be reduced to smoke is done. Considering that smoke is minute particles carried on hot gasses, even these particles are burned until they are almost completely broken down. There is hardly anything left to smell.

In most cases, cremated remains are odourless. They may have a slightly metallic odour or some people say they smell somewhat like incense in some cases. However, it is common for ashes to have no distinct smell. Nonetheless, they can take on the smell of the container or cremation urn they are in.

11. Mitigation Measures

The best available techniques to avoid crematorium air pollution are those that consider both technology and management. Control of persistent organic pollutants would comprise the following items and considerations (UNEP, 2008):

- A cremator meeting the minimum temperature, residence time and oxygen requirements and demonstrated to meet those requirements;
- Suitable air pollution control equipment (for control of persistent organic pollutants this would need to include temperature management to control residence time in reformation window, carbon injection and fabric filtration or equivalent) along with culturally and environmentally appropriate burying of any collected material;
- Combustion chambers and casings should be made as airtight as possible and operate under reduced pressure to minimize release of furnace gases;
- Gas temperatures should be monitored to allow control systems to maintain minimum temperature criteria (through use of support fuel burners) and provide interlocking to stop charge when temperature falls below minimum;

- Flue gas oxygen and carbon monoxide levels should be monitored and linked to the control system to ensure adequate control of air supplies and address any combustion problems;
- Mechanized loading and handling of coffins to minimize exposure to operators;
- Coffin storage facilities to be refrigerated, lockable and rodent and bird proof and have odour control;
- Coffin and coffin fittings should be made of combustible material. Avoid use, or inclusion, of articles containing PVC, metals and other chlorinated compounds;
- Effective operation control, inspection and preventive maintenance of components whose failure could impact on the environment by releasing persistent organic pollutants;
- Operator competencies to be identified and met by suitable training;
- Application of emission limit values and the annual monitoring of emissions to demonstrate emission compliance for persistent pollutants.

11.1. Workers in a crematorium

According to Cui et al., (2021) cremators, incinerators, and post-processing devices are all installed in cremation workshops and operated indoors. Consequently, a large quantity of unorganized odour emissions accumulates inside the workshop and impact the health of the workshop staff. Several studies have highlighted the potential risks of inhaling radioactive ashes by crematorium staff or members of the public. Due to the prolonged half-life of some radioisotopes, if the patient dies soon after implantation, then the cremated remains would also remain radioactive (Smith *et al.*,2012). This causes a hazard to the staff and those who handle the remains, until placed into a metal urn. Pacemakers and expandable orthopaedic nails are also two potential dangers to cremation staff. Studies conducted by Korczynski (1997) and Maloney et al., 1998) exposure to Hg to be higher amongst crematoria staff than in a control population, and exposure to fine particulates may occur, particularly where there are no operational and engineering controls to reduce exposure to dust.

11.2. Mitigation Measures

Mitigation measures:

- Assessing and ensuring hygiene is maintained in line with funeral parlour legislation, regulations relating to the management of human remains, Government Notice No. 363 of 22 May 2013
- Training: Staff at all levels need the necessary training and instruction in their duties relating to control of the process and emissions to air. In order to minimise risk of emissions, particular emphasis should be given to control procedures during start-up, shut down and abnormal conditions;
- Maintenance: Effective preventative maintenance plays a key part in achieving compliance with emission limits and other provisions. All aspects of the process including all plant, buildings and the equipment concerned with the control of emissions to air should be properly maintained;

- Bi-annual air quality monitoring for the first year of operations, then annually for the rest of the duration of the operational phase of the Project;
- Air quality monitoring should be conducted by appropriately trained operating staff;
- Exhaust flow rates should be installed. These should be consistent with efficient capture of emissions, good operating practice and meeting the requirements of the legislation relating to the workplace environment.
- Minimum furnace temperature (850 °C), residence time in the second chamber (2 seconds for combustion gases) and enough air to ensure combustion in the second chamber and avoid generating products of incomplete combustion;
- Suitable air pollution control equipment, which could include temperature controls, dust control, carbon injection, fabric filtration, air tightness of combustion chambers and casings;
- Monitoring of gas temperature and flue gas O_2 and CO concentrations, application of relevant emission limit values and additional monitoring of ambient air quality in the proximity of crematoria;
- The presence of PVC, metals and other contaminants (particularly chlorine compounds) in the coffin material and furnishings should be avoided to reduce the generation of persistent organic;
- Use of waste-derived or other fuels potentially contaminated with persistent organic pollutants should be minimized
- Operational controls, inspection and preventive maintenance;
- Sealed furnaces are essential to contain fugitive emissions while permitting heat recovery and collecting off-gases for abatement or discharge;
- Particulate matter should be removed to reduce PCDD/PCDF emissions to atmosphere;
- All crematorium staff involved in such a case should wear a mask and rubber gloves when handling the cremated materials, all cremated remains should be put in a metal urn, any unwanted radionuclides should decay in storage for 20 months before being discarded, and remains should not be scattered until 20 months after the date of implantation;
- Other good practice measures to protect crematoria workers, such as removal of radioactive implants before cremation, informing crematoria workers of recent radiotherapy treatments for deceased patients, and safe handling practices for ashes, can also reduce possible environmental releases of pollutants.

Carbon dioxide emissions from gas usage are the main greenhouse gas component of crematoria's carbon footprint. The applicant may wish to note that the development of an energy reduction strategy will have the benefits

of saving money and reducing their carbon footprint. A measure as simple as recording of gas consumption (e.g., comparison of quarterly gas bills) is a first step in managing energy use and therefore CO_2 emissions.

Table 11-1: Measures for pollutants of most concern from crematoria emissions (O'Keeffe, 2020)

Control Measure(s)	Pollutants			
	PCDD/Fs	Hg	$PM_{2.5}$	Radioactivity
Source Control				
Removal of plastics	*		*	
Non-toxic and eco-friendly coatings or materials in caskets	*			
Removal of Hg fillings		*		
Removal of medical devices containing radioactive material				*
Operational Control				
Minimum 850°C (2nd chamber)	*		*	
Minimum residence time of 2 s (2nd chamber)	*		*	
Adequate O_2 in combustion chamber	*		*	
Monitoring CO releases	*		*	
Air tightness of combustion chambers and casings	*	*	*	*
Maintenance	*	*	*	*
Operator training	*	*	*	*
Emission controls				
Dust control (filters and scrubbers)	*		*	
Activated carbon treatment	*	*		
Hg removal technology (binding, precipitation etc.)		*		
Adequate chimney height	General dispersion and dilution of pollutants higher into atmosphere			

The table above indicates the measure which can help reduce emissions may be employed in order to monitor the various control on the key pollutants associated with the crematorium.

For comprehensive management and control of unorganized odour emissions in workshops, workshop ventilation should be improved, and exhaust fans should be installed considering practical conditions, such that low-concentration unorganized odour emissions can be promptly diluted and discharged. Additionally, equipment should be operated in an intermittent working mode to reduce odour accumulation in the workshop associated with the workload.

The following table provides a summary of the best available techniques that can be used to control the cremation process

Table 11-2: Summary of control techniques

Release source	Substance	Control techniques
Flue gas	Nitrogen oxides	No control
	Odour	Good combustion and a secondary combustion zone
	Carbon monoxide	Good combustion and a secondary combustion zone
	Volatile organic compounds	Good combustion and a secondary combustion zone
	PAH	Good combustion and a secondary combustion zone
	Mercury and its compounds	Abatement, or contribute via burden sharing scheme
	Particulate matter	Good combustion, slow gas velocities and a secondary combustion zone. Abatement further minimises emissions*
	Hydrogen chloride	Minimise halogens combusted, avoid excessive temperature in primary chamber. Abatement further minimises emissions*
	PCDD/F	Minimise chlorine combusted and particulate matter emitted, good combustion and a secondary combustion zone, Abatement further minimises emissions*
	Carbon dioxide	Measure gas consumption, good cremator design
Cremated remains size reduction machine	Particulate matter	Filter on machine or external dispersion and filter if needed.
Spent gas-cleaning materials	Particulate matter, mercury	Keep containers tightly lidded
* if fitted for mercury abatement purposes		

12. Conclusion

It is acknowledged that design and operations parameters play a significant role in ensuring reduced emissions caused by the cremating processes, as such we confirm that Johnson Thermal Engineering are the designers of the JTE BA1 and BA2 Cremator Machines, locally manufactured and distributed in South Africa by Engineered Thermal Systems (Pty) Ltd, which is the machinery that Platinum Pride intend to use in the proposed Platinum Pride Crematorium Project. This machinery expected to significantly reduce emission and in turn reduces any health impact to the surrounding community which may occur due to the proposed Platinum Pride Crematorium Project.

The Management and control measure of odour emissions and contaminants in crematorium may be reduced and / or eliminated through installation of ventilators and exhaust fans, considering practical conditions, such that low-concentration odour emissions can be promptly diluted and discharged. Furthermore, equipment will be operated in an intermittent working mode to reduce odour accumulation in the workshop associated with the workload.

In addition, depending on proximity to other criteria air pollutant emission sources, some of the pollutants of concern listed in this Report may already be present in ambient air at the point of impingement of the crematorium plume, contributing to exposure concentrations in excess of those estimated in the AQIA. Individuals in the surrounding industrial area may also be exposed to, for example, elemental mercury through dermal contact with mercury present in soil, or through ingestion of contaminated food or water, for example. Crematorium installations should implement processes such as filters to reduce their atmospheric emissions to limit mercury emission. The effects of multiple sources of air pollution (considering that the proposed Crematorium is to be located in an existing industrial area, surrounded by several contributors to air pollution) and routes/ pathways of exposure (dermal, air, consumption etc.) should be considered in an assessment of individual risk associated with exposure to any perceived pollutants from the crematorium - people may also be exposed to the identified pollutants such as mercury for example, through dermal contact with mercury present in soil, or through ingestion of contaminated food or water, etc. Section 10.1 of this Report has discussed impacts these pollutants and their potential impacts to human health.

The property is zoned as General Industry Zone 1 which permits a crematorium. It is of the opinion of the author that the proposed Project poses negligible to no risk to human health. The author does, however, recommend that air quality emissions be monitored bi-annually in the first year of operations, then annually for the rest of the duration of the operational phase of the crematorium and an analysis on those results should be conducted where a specific concern exists.

To ensure that the proposed crematorium does not cause adverse health impacts to both the employees and the surrounding areas, the mitigation measure stipulated in the HIA and the air quality study should be implemented and the requirements stipulated in the National Health Act (Act 61 of 2003) should be adhered to.

This Study is subject to a set of assumptions and estimations related to parameters that were applied to assess air quality and health risk.

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Appendices

Appendix A

Expertise of Specialist (CV)

Vumile Ribeiro (Dlamini)

Director: Environmental Management Services

Curriculum Vitae

Niara Environmental Consultants (Pty) Ltd
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Linden, Johannesburg

Mpumalanga Office:
16 Birkholtz Avenue,
Witbank Ext 16,
eMalahleni, 1034

Curriculum Vitae of Vumile Ribeiro

Director: Environmental Management Services

Vumile Dlamini-Ribeiro is the Director of Environmental Management Services at Niara Environmental Consultants (Pty) Ltd. Vumile has 15 years of professional and international experience in Environmental Assessment and Management primarily in the minerals resources and energy sector. Her roles include the operational management responsibilities of Niara Environmental Consultants, project management, report writing, client liaison, as well as business development.

Having worked for a multi-disciplinary advisory firms and environmental consultancies, Vumile has a competent understanding of the work effort and cross collaboration required for a successful multidisciplinary organisation. Vumile has been involved in a number of Environmental Impact Assessments and has a particular interest in health impacts assessments, water resource management, mining, energy and stakeholder engagement. Vumile has considerable experience across a range of developmental and environmental sciences and has worked in South Africa, Mozambique, Sierra Leone and Liberia and is familiar with Regulatory Environmental Legislation in other parts of Africa.

Vumile is very well versed in the IFC Environmental and Social Performance Standards (including IFC PS 2012) and the associated Equator Principles, which have informed the approach and standard for a number of ESIA processes that she has been involved in. Vumile is skilled at organising and driving effective project teams at a scale relevant to the project's requirements. She has technical experience and is able to quickly identify the most pertinent issues of a particular project whilst focussing on driving project success by rigorously implementing project management tools.

28 Shamrock Street, Ferndale Ext 3, Randburg 2194, Johannesburg	
+27 (0) 82 767 2786	
vumile@niara.co.za	
Vumile Ribeiro	

Key Competencies:

- Project Management
- Health Impact Assessments
- Legal Compliance Audits: Environmental / Health & Safety
- Environmental Control Officer
- Performance Assessments (Environmental Audits) on mine EMPrs
- Compliance audits on environmental authorisations (e.g. ROD's, water, air and waste licenses)
- Consolidated Compliance Programmes
- Environmental Impact Assessments
- Basic Assessment Reports
- Mineral Law -Mining Rights and Permits
- Environmental Authorisation Applications
- Water Use License Applications
- Waste Management License Applications
- Co-ordinating and conducting Public Involvement processes.
- Qualitative and Quantitative Social Research
- Social Assessment (Stakeholder and Social Analysis)
- Public Participation Process and Stakeholder consultation and mediation

Education:

- BSocSc. (Geography and Environmental Management) University of KwaZulu Natal (2007)
- BSocSc. Hons. (Environmental Analysis and Management) University of Pretoria (2011)
- MPhil. (Environmental Law) University of Pretoria (current)

Language Skills:

- English (excellent)
- isiZulu (excellent)
- siSwati (excellent)
- Xhosa (excellent)
- Afrikaans (intermediate)

Employment:

- June 2017 – present: Director: Environmental Management Services, Niara Environmental Consultants
- March 2012 – May 2017: Environmental Consultant Human Sciences Department, Digby Wells Environmental, South Africa
- January 2010 – December 2010: GIS Technician, Niara Environmental Consultants
- October 2008 – October 2009: Client Service Executive, Ernst & Young
- July 2007 – August 2008: GIS technician Capturer, Geospace International, (City of Tshwane Public Works and Infrastructure Development Department: Roads and Storm Water Division Project.)
- April 2007 – July 2007: Mineral information Management Intern Department of Minerals and Energy, Mpumalanga Regional Office

Project Experience:

Duration	Assignment name/ brief description of main deliverables/outputs	Name of client and country of assignment	Role on the assignment
2012	Scoping EIA and Water Use License Application for the Bokoni Platinum Mine: Klipfontein Opencast Mining Operation	Bokoni Platinum Mines (Pty) Ltd Republic of South Africa	Project Administrator
2012	Amendment to City Deep EIA/EMP for the inclusion of Dump 3/L/40 and 3/L/42	Ergo Mining (Pty) Ltd Republic of South Africa	Project Assistant
2012	Community Health Baseline Study for Tonguma	Koidu Holdings Sierra Leone	Project Assistant/ Report Writer
2012-2013	Community Health Impact Assessment for the Cooke Uranium Project re-mining of historic tailings facilities and establishment of a single large new Tailings Storage Facility for residual tailings	Gold One International Ltd Republic of South Africa	Health Specialist/ Report Writer
2012-2013	Water Use Licence Compliance Audit	Ergo Mining (Pty) Ltd Republic of South Africa	Project Administrator
2013	Community Health Impact assessment for the Vedanta Power Plant and Associated Transmission Lines	Vedanta Zinc International Republic of South Africa	Health Specialist/ Report Writer
2013	Community Health Impact Assessment for the Balama Graphite Mine	Syrah Resources Mozambique	Health Specialist/ Report Writer
2013	Community Health Impact Assessment for the Putu Iron Ore Project	Atkins Global, Grand Gedeh County, Liberia	Project assistant for Health Impact Assessment
2013	Prospecting Right Application and Environmental Management Program Compilation for the St. Agnesfontein	Glenover Phosphate (Pty) Ltd/ FermineOre, Republic of South Africa	Project Administrator
2013-2014	Scoping EIA, Water Use License Application, Waste Management Licence Application for the Sasol Sigma Colliery Underground Ash Backfilling Project	Sasol Mining (Pty) Ltd Republic of South Africa	Project Administrator

Duration	Assignment name/ brief description of main deliverables/outputs	Name of client and country of assignment	Role on the assignment
2013-2014	Basic Assessment Report, Scoping EIA, Water Use License Application for the Sasol Syferfontein Block 4 Expansion Project	Sasol Mining (Pty) Ltd Republic of South Africa	Project Administrator
2013-2014	Community Health Impact Assessment for the Platreef underground platinum mine operation	Platreef Resources (PTY) Ltd Republic of South Africa	Health Specialist/ Report Writer
2014	Submission of revised Environmental Impact Assessment and Environmental Management Programme for the Trichardtsfontein Project	Glencore Operations South Africa (Pty) Ltd, Republic of South Africa	Project Administrator/ Report Co-author
2014	Amendment to the Nooitgedacht Environmental Impact Assessment and Environmental Management Programme: Inclusion of Seams 2 and 4	Glencore Operations South Africa (Pty) Ltd, Republic of South Africa	Project Administrator/ Report Co-author
2014	Community Impact Assessment for the proposed Kamiesberg heavy mineral sands mine Project	Zirco Roode Heuwel (Pty) Ltd Republic of South Africa	Health Specialist/ Report Writer
2014	Community Impact Assessment for the proposed Tenge Iron Ore Project	Capitol Resources Limitada –subsidiary of Baobab Resources Plc, Mozambique	Health Specialist/ Report Writer
2015	Integrated Water Use Licence Application and Integrated Waste Water Management Plan for the proposed Klipspruit Extension: Weltevreden	BHP Billiton Energy Coal South Africa Limited, Republic of South Africa	Project assistant for the WULA and IWWMP
2015	Integrated Water Use Licence Application for the proposed Middelburg – Mhluzi Powerline Project	Eskom SOC Holdings Limited Republic of South Africa	Project Manager/ Report Writer for the WULA

Duration	Assignment name/ brief description of main deliverables/outputs	Name of client and country of assignment	Role on the assignment
2015	Community Health Impact Assessment for the proposed open-pit magnetite mine and concentrator plant	Pamish Investments No. 39 (Pty) Ltd Republic of South Africa	Health Specialist/ Report Writer
2015	Environmental and Social Impact Assessment for the Proposed Nachu Graphite Project	Magnis Resources T/A Uranex Tanzania Ltd, Ruangwa District, Lindi Region Tanzania, East Africa	Health Impact Assessment Report Reviewer
2015	Integrated Water Use Licence Application and Integrated Waste Water Management Plan for the Lanxess Chrome Mine	Lanxess Mining (Pty) Ltd Republic of South Africa	Report Writer for the WULA and IWWMP
2015	De Groote Boom Mining Permit Application: Prescribed Environmental Management Programme	De Groote Boom Minerals (Pty) Ltd Republic of South Africa	Project Administrator and Report Writer
2015	Environmental Impact Assessment and Environmental Management Programme Report for the Proposed Realignment of the P141-1 Provincial Road, Tweefontein Mine Complex, Mpumalanga Province	Glencore Operations South Africa (Pty) Ltd	Report Compiler
2015	Water Use Licence Application for the Proposed Realignment of the P141-1 Provincial Road, Tweefontein Mine Complex, Mpumalanga Province	Glencore Operations South Africa (Pty) Ltd, Republic of South Africa	Report Writer for the WULA and IWWMP
2015	Community Impact Assessment for the GK Ancuabe Graphite Mine	Graphit Kropfmühl Ancuabe Graphite Mine SA, Cabo Delgado Province Mozambique	Project Manager/ Health Specialist/ Report Writer
2015	Water Use Licence Application for the Proposed Roodekop Wetland Offset and Compensation Strategy Project	Universal Coal Development IV (Pty) Ltd Republic of South Africa	Report Writer for the WULA and IWWMP

Duration	Assignment name/ brief description of main deliverables/outputs	Name of client and country of assignment	Role on the assignment
2015	Water Use Licence Application for the proposed Lambda Substation near Volksrust, Mpumalanga and Associated 2 x 400kV & 2 x 765kV Loop in Transmission Line Project	Eskom SOC Holdings Limited Republic of South Africa	Project Manager
2016	Klipspruit Extension: Motivation for The Drilling Of Exploration Holes Within A Wetland	South32 Sa Coal Holdings (Pty) Ltd	Project Administrator/ Report Writer
2016	Namane Generation Independent Power Producer and Transmission Line Project, near Lephalale, Limpopo	Namane Generation (Pty) Ltd	Health Specialist
2016	Risk Assessment and Associated General Authorisation for the Proposed KPSX Northern Bypass, in Mpumalanga	South32 SA Coal Holdings (Pty) Limited	Project Manager and Report Writer
2016	Environmental and Social Impact Assessment for the Massawa and Sofia Gold Project, Senegal	Randgold Resources Limited	Health Specialist
2016	Proposed Reclamation of the Grootvlei Tailings Storage Facilities Cluster, near Springs, Gauteng	Ergo Mining (Pty) Ltd Republic of South Africa	Health Specialist
2017	Environmental and Social Impact Assessment for the Proposed Ntem Iron Ore Project, in Cameroon: Health Impact Assessment Report	Caminex SA, Cameroon	Health Specialist
2017	Water Use Licence for the Proposed Pit H and Associated Infrastructure at KPSX: Weltevreden and KPSX: South Operations, in Mpumalanga	South32 SA Coal Holdings (Pty) Limited, Republic of South Africa	Project Manager and Report Writer
2017	Risk Assessment and Associated General Authorisation for the Proposed Substation and 132kV Power Lines in Ogies, Mpumalanga	Eskom Holdings SOC Limited, Republic of South Africa	Project Manager and Report Writer
2017	Wetlands Risk Assessment and Associated General Authorisation for the Proposed Geotechnical Drilling Project at Khutala Colliery, in Mpumalanga	South32 SA Coal Holdings (Pty) Limited, Republic of South Africa	Project Manager and Report Writer
2017	Community Health Impact Assessment for the Proposed Phase 2 KwaMathukuza Housing Development in KwaMathukuza, Newcastle, KwaZulu-Natal	Phumaf Consulting Engineers, Republic of South Africa	Project Manager and Report Writer

Duration	Assignment name/ brief description of main deliverables/outputs	Name of client and country of assignment	Role on the assignment
2017	Odour Survey/ Assessment for the Proposed Phase 2 KwaMathukuza Housing Development in KwaMathukuza, Newcastle, KwaZulu-Natal	Phumaf Consulting Engineers, Republic of South Africa	Project Manager and Report Writer
2017	Health Impact Assessment for the Mining Right Application for Iron Ore for Muhlava Mining on the Farms Berlyn 670 LT and Keulen 669 LT in Tzaneen, Limpopo Province	Titanium Mining (Pty) Ltd, Republic of South Africa	Project Manager and Report Writer
2017	Emakhazeni Coal Mining Project in the Eastern Basin Coalfield, Mpumalanga Province	Umsimbithi Mining (Pty) Ltd, Republic of South Africa	Health Specialist
2017	Odour Impact Survey for the Proposed Phase 2 KwaMathukuza Housing Development in KwaMathukuza, Newcastle, KwaZulu-Natal	Phumaf Consulting Engineers, Republic of South Africa	Project Manager and Report Writer
2018	Renewal of an Existing Integrated Water Use License for Vlakfontein Mine: Central Block, Ogies in Mpumalanga Province	African Exploration Mining and Finance Corporation SOC Limited (AEMFC)	Project Manager and Report Writer
2018	2017 IWWMP Update and Amendment for Eskom Lethabo Power Station in Free State	Eskom Holdings SOC Limited	Project Manager and Report Writer
2018	East Block External Integrated Water Use License Audit at Vlakfontein Mine, Ogies in Mpumalanga Province	African Exploration Mining and Finance Corporation SOC Limited (AEMFC)	Project Manager and Report Writer
2018	Waste Management License Application for NN Metals proposed listed activities of the scrap metal recycling operation located at 300 Mundt Street on Waltloo township ERF 110 in Pretoria within the City of Tshwane Metropolitan Municipality	NN Metals (Pty) Ltd, Pretoria, Republic of South Africa	Project Manager and Report Writer
2018	Community Health Impact Assessment for The Development of the Proposed Leslie 1 Coal Mining Project, near Leandra, Mpumalanga Province	Anglo Operations (Pty) Ltd and Leslie Coal Mine (Pty) Ltd	Health Specialist

Duration	Assignment name/ brief description of main deliverables/outputs	Name of client and country of assignment	Role on the assignment
2018	The Development of the Proposed Transformer Manufacturing, Repairing and Testing Facility at Portion 189 of the Farm Zandfontein 317JR, Kirkney Industrial Township, Pretoria West: Health Impact Assessment	Contipower (Pty) Ltd	Health Specialist
2018	Elandsfontein Colliery: Oosbank Coal Siding Draft Environmental Management Programme	Anker Coal, Elandsfontein Colliery (Pty) Ltd	Project Manager and Report Writer
2018	Elandsfontein Colliery (Pty) Ltd: Elandsfontein Mine Integrated Water and Waste Management Plan Annual Update: 2018	Anker Coal, Elandsfontein Colliery (Pty) Ltd	Project Manager and Report Writer
2018	Rehabilitation, Decommissioning and Mine Closure Plan for the Proposed Woestalleen Holdings (Pty) Ltd Coal Mine in Middelburg, Mpumalanga Province	Woestalleen Holdings (Pty) Ltd	Project Manager and Report Writer
2019	Elandsfontein Colliery: Performance Assessment Audit Report on MP 63 MR Environmental Management Programme	Anker Coal, Elandsfontein Colliery (Pty) Ltd	Project Manager and Report Writer
2019	Community Health Impact Assessment The Development of the Proposed Matai Mining Project in Mankwe District, North West Province	Matai Mining (Pty) Ltd	Project Manager and Report Writer
2019	Social Impact Assessment The Development of the Proposed Matai Mining Project in Mankwe District, North West Province	Matai Mining (Pty) Ltd	Project Manager and Report Writer
2019	Health Impact Assessment Report The Development of the Proposed Panfontein Mining Project in the Magisterial District of Vereeniging, Gauteng Province	Richtrau 253 (Pty) Ltd	Project Manager and Report Writer

Duration	Assignment name/ brief description of main deliverables/outputs	Name of client and country of assignment	Role on the assignment
2019	Socio-economic Impact Assessment Report The Development of the Proposed Panfontein Mining Project in the Magisterial District of Vereeniging, Gauteng Province	Richtrau 253 (Pty) Ltd	Project Manager and Report Writer
2019	Elandsfontein Colliery (Pty) Ltd: Elandsfontein Mine Integrated Water and Waste Management Plan and RSIP Annual Update: 2019	Anker Coal, Elandsfontein Colliery (Pty) Ltd	Project Manager and Report Writer
2019	Vlakfontein Colliery Financial Provision Assessment: 2019	African Exploration Mining and Finance Corporation (SOC) Ltd (AEMFC)	Project Manager and Report Reviewer
2019	Inyanda Coal Mine Integrated Water and Waste Management Plan Update: 2019	Inyanda Mining Holdings (Pty) Ltd	Report Writer
2019	Inyanda Coal Mine Rehabilitation Strategy and Implementation Plan	Inyanda Mining Holdings (Pty) Ltd	Report Writer
2019	Health Risk Assessment for The Proposed Residential Development on Various Portions of The Farm Rooikoppies 297-JQ	Seaton Thomson and Associates Cc	Specialist and Report Writer
2019	Application for Environmental Authorisation and A Change of Land Use for the Proposed Musina-Makhado Special Economic Zone (SEZ) in the Limpopo Province Health Impact Assessment Report	Limpopo Economic Development Agency (LEDA)	Specialist and Report Writer

Duration	Assignment name/ brief description of main deliverables/outputs	Name of client and country of assignment	Role on the assignment
2019	Integrated Environmental Authorisation Process for the Proposed Weltevreden Mining Right Application, Socio-economic Impact Assessment Report	Saldomate (Pty) Ltd	Specialist and Report Writer
2019	Integrated Environmental Authorisation Process for the Proposed Wildebeestfontein Mining Right Application, Socio-economic Impact Assessment Report and Social and Labour Plan	Opsirex (Pty) Ltd	Specialist and Report Writer
2020	Proposed Aggregate and Gravel Mining in Bizana, Eastern Cape: Social and Labour Plan	Ilitye Industrial (Pty) Ltd	Specialist and Report Writer
2020	Integrated Water Use Licence Application and IWWMP: Inyanda Coal Mine Rehabilitation Strategy and Implementation Plan	Inyanda Mining Holdings (Pty) Ltd	Report Writer
2020	Integrated Water Use Licence Application and IWWMP: The Development of the Proposed Panfontein Mining Project in the Magisterial District of Vereeniging, Gauteng Province	Richtrau 253 (Pty) Ltd	Project Manager and Report Writer
2020	Integrated Environmental Authorisation Process for the Proposed Van Oudshoornstroom Mining Right Application: Socio-economic Impact Assessment Report	Estate Late Philippus Christoffel Johannes De Jager	Specialist and Report Writer
2020	Nkomati Mine Closure Project: Community and Occupational Health Assessment	Nkomati Joint Venture – a partnership between African Rainbow Minerals Limited and Norilsk Nickel Africa (Pty) Limited (Nkomati Mine	Specialist and Report Writer

Duration	Assignment name/ brief description of main deliverables/outputs	Name of client and country of assignment	Role on the assignment
2020	Social Impact Assessment Report for the Development of the Proposed Zelpy Kafferskraal Mining Right Application	Zelpy Gold Mine (Pty) Ltd	Specialist and Report Writer
2020	Health Impact Assessment Report for the Development of the Proposed Zelpy Kafferskraal Mining Right Application	Zelpy Gold Mine (Pty) Ltd	Specialist and Report Writer
2020	Environmental Authorisation and Water Use Licence Application for The Electrisurv Cc Beneficiation Plant	Electrisurv Surveying CC	Project Manager and Reports Writer
2020	Mining Right Application of the Proposed Springfield Opencast Colliery, near Meyerton & Vereeniging in the Gauteng Province: Health Impact Assessment	Glubay Coal (Pty) Ltd, an affiliated company of Canyon Resources (Pty) Ltd	Specialist and Report Writer
2020	Koppie Canyon Mining Right Application near Hendrina, Mpumalanga: Social Impact Assessment Report and Social and Labour Plan	Canyon Resources (Pty) Ltd	Specialist and Report Writer
2020	Risenga Colliery Water Use Licence Application: Integrated Water and Waste Management Plan	SARMCO Group (Pty) Ltd	Project Manager and Report Writer
2021	Integrated Water and Waste Management Plan (IWWMP) for the Proposed Samara Prospecting Right near Barkley West, Northern Cape	Samara Mining (Pty) Ltd	Specialist and Report Writer

Duration	Assignment name/ brief description of main deliverables/outputs	Name of client and country of assignment	Role on the assignment
2021	Social Impact Assessment Report and Social and Labour Plan for the Development of the Lakeside Colliery S102 Amendment	Zomhlaba Resources (Pty) Ltd	Specialist and Report Writer
2021	Social Impact Assessment Report and Social and Labour Plan for the Development of the Leeuwfontein Colliery S102 Amendment	Zomhlaba Resources (Pty) Ltd	Specialist and Report Writer
2021	Health Impact Assessment Report for the Development of the Proposed Ericure Dannhauser Coal Project	Ericure (Pty) Ltd	Specialist and Report Writer
2021	Application for Environmental Authorisation and Water Use Licence Application for the Proposed Middelburg Mining Services (MMS) Boschmanskrans Section Implementation of Wetland Mitigation and Offset Strategy: Social Impact Assessment	South32 SA Coal Holdings (Pty) Limited: South Africa Energy Coal	Specialist and Report Writer
2021	Application for General Authorisation: Ifalethu Colliery, Middelburg, Mpumalanga	South32 SA Coal Holdings (Pty) Limited: South Africa Energy Coal	Specialist and Report Writer
2021	Application for Environmental Authorisation and Water Use Licence Application for the Proposed Middelburg Mining Services (MMS) Boschmanskrans Section Implementation of Wetland Mitigation and Offset Strategy: Water Use Licence Application	South32 SA Coal Holdings (Pty) Limited: South Africa Energy Coal	Specialist and Report Writer
2021	Social Impact Assessment for the Proposed Farm Marsh Lusern and Hydroponics Systems Project: Social Impact Assessment	Sishen Iron Ore Company (Pty) Ltd	Specialist and Report Writer

Duration	Assignment name/ brief description of main deliverables/outputs	Name of client and country of assignment	Role on the assignment
2021	Environmental Regulatory Process Required for the Proposed Wolvekrans Colliery Boschmanskrans Section Mining Extension Project Wetland Mitigation and Offset Strategy near Middelburg, Mpumalanga	South32 SA Coal Holdings (Pty) Ltd	Project Manager
2021	Water Use Licence Application for the Proposed Wolvekrans Colliery Boschmanskrans Section Mining Extension Project Wetland Mitigation and Offset Strategy	South32 SA Coal Holdings (Pty) Ltd	Specialist and Report Writer
2021	Social Impact Assessment for the Proposed Wolvekrans Colliery Boschmanskrans Section Mining Extension Project Wetland Mitigation and Offset Strategy	South32 SA Coal Holdings (Pty) Ltd	Specialist and Report Writer
2021	Environmental Impact Assessment and IWUL for the Proposed Ikwezi Vanadium Mine, near Northam	Ikwezi Mining (Pty) Ltd	Project Manager
2021	Social Impact Assessment and IWUL for the Proposed Ikwezi Vanadium Mine, near Northam	Ikwezi Mining (Pty) Ltd	Specialist and Report Writer
2021	Integrated Environmental Authorisation Process for The Proposed Aangewys Coal Mine Mining Right Application: Social Impact Assessment	National Treasure Minerals (Pty) Ltd	Specialist and Report Writer
2021	Social and Labour Plan for The Proposed Straffontein Colliery Mining Right Application	Mnambithi Mining (Pty) Ltd	Specialist and Report Writer

Duration	Assignment name/ brief description of main deliverables/outputs	Name of client and country of assignment	Role on the assignment
2021	Integrated Environmental Authorisation Process for The Proposed Straffontein Colliery Mining Right Application: Social Impact Assessment	Mnambithi Mining (Pty) Ltd	Specialist and Report Writer
2021	Environmental Authorisation and Water Use Licence Application for The Construction of the Doornpoort Pumping Main and Pump Station Project	eMalahleni Local Municipality	Project Manager and Report Writer
2021	Environmental Audit Report for Sekoko Coal – 2021	M3P Mining (Pty) Ltd	Project Manager
2021	Environmental Authorisation required for Prospecting Right Application on various Portions of the Farm Schaapkopje 194 HT, 5km North of Vryheid Town in the AbaQulusi Local Municipality, KwaZulu Natal	Tuutuuka Resources (Pty) Ltd	Project Manager and Report Writer
2021	Basic Assessment Process and Water Use Licence Application for the Alignment of the Klipspruit Colliery Environmental Management Programme for Klipspruit Colliery, Mpumalanga Province	Seriti Power (Pty) Ltd	Project Manager and Report Writer
2022	Social and Labour Plan for The Proposed Roodepoort Coal Mine	Roodepoort Coal (Pty) Ltd	Specialist and Report Writer
2022	Social Impact Assessment for The Proposed Roodepoort Coal Mine on Farm Roodepoort 40 Is Portion 15, Nkangala District Municipality Within the EMalahleni Local Municipality, Mpumalanga Province	Roodepoort Coal (Pty) Ltd	Specialist and Report Writer

Duration	Assignment name/ brief description of main deliverables/outputs	Name of client and country of assignment	Role on the assignment
2022	Social and Labour Plan for Kleinwater Colliery	Madini Mining (Pty) Ltd	Specialist and Report Writer
2022	Social Impact Assessment for the Section 102 Amendment in Respect of Portions 2, 8, 9 of the Farm Kleinwater 301 JS, Portions 11, 39, 40 Of the Farm Doornrug 302 JS, and the Remaining Extent of the Farm Rondebult 303 JS, eMalahleni Local Municipality, Mpumalanga	Madini Mining (Pty) Ltd	Specialist and Report Writer
2022	Health Impact Assessment for the Proposed Nellmapius Extension 26 Township on Various Portions of The Farm Hatherley 331 JR, City of Tshwane Metropolitan Council	Tambura 69 Trust	Specialist and Report Writer
2022	Environmental Impact Assessment (EIA) and Water Use Licence Application for The Grootlaagte Opencast Mine Mining Right Application Situated in The Steve Tshwete Local Municipality, Nkangala District Municipality in Mpumalanga	Arnot OpCo (Pty) Ltd	Project Manager and Report Writer
2022	Basic Assessment Process and Water Use Licence for The Proposed Upgrade of Weltevreden Wetland Interventions	Seriti Power (Pty) Ltd	Project Manager and Report Writer
2022	Social Impact Assessment for the Blesboklaagte S102 EA IWUL and WL	Eyethu Coal (Pty) Ltd	Specialist and Report Writer
2022	Environmental Authorisation for Klipspruit Colliery - Pit H: Regulation 31 Amendment and Water Use License Application	Seriti Power (Pty) Ltd	Project Manager and Report Writer
2022	Social Impact Assessment for the proposed Wonderhoek Open Cast Coal Mine near Middelburg, Mpumalanga Province	Wonderhoek Colliery (Pty) Ltd	Specialist and Report Writer

Duration	Assignment name/ brief description of main deliverables/outputs	Name of client and country of assignment	Role on the assignment
2022	Community Health Impact Assessment for the proposed Interwaste Brakkefontein Waste Management Facility near Atlantis, Western Cape	SLR Consulting on behalf of Interwaste (Pty) Ltd	Specialist and Report Writer
2022	Community Health Impact Assessment for the proposed Wonderhoek Open Cast Coal Mine near Middelburg, Mpumalanga Province	Wonderhoek Colliery (Pty) Ltd	Specialist and Report Writer
2022	Community Health Impact Assessment for the proposed Schurvekop Underground Coal Mine near Bethal in Mpumalanga	Mmakau Coal (Pty) Ltd	Specialist and Report Writer
2022	Public Participation Process in Support of the Queenstown Quarry S102 Amendment Process, Eastern Cape	Raumix Aggregates, a subsidiary of Raubex Group Ltd	Public Participation Practitioner
2022	Community Health Impact Assessment for the proposed Arengo Iron-Ore Project	Arengo 297 (Pty) Ltd	Specialist and Report Writer
2022	Water Use Licence Application and Associated Specialist Studies for the proposed Idwala Coal Mine	Idwala Coal Mine (Pty) Ltd	Specialist and Report Writer
2022	Rapid Appraisal Health Impact Assessment for the Proposed Platinum Pride Crematorium in Cape Town	Sharples Environmental Services cc (SES)	Specialist and Report Writer

Professional Affiliations:

- International Association of Impact Assessment South Africa (IAIASA)
- Public Health Association of South Africa (PHASA)
- National Association for Clean Air (NACA)

PHASA
Public Health Association of South Africa

MEMBERSHIP CERTIFICATE

This certifies that

Vumile Ribeiro

is a registered member of the **Public Health Association of South Africa**

Membership number: 2021380

Membership period ends: 31st July 2023

25th July 2022

Date

PHASA President

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IAIAsa Confirmation of Membership: 2022/2023
Vumile Ribeiro (Dlamini) Membership Number: 5925

03 Mar 2022

TO WHOM IT MAY CONCERN

Mrs Vumile Ribeiro (Dlamini), Niara Environmental Consultants (IAIAsa membership Number **5925**) is a paid-up Full Member in good standing of International Association for Impact Assessment, South Africa and has been a member of IAIAsa since 01 Mar 2018.

Membership has been continous from 01 Mar 2018 to date.

This membership is valid from 01 Mar 2022 to 28 Feb 2023.

IAIAsa is a voluntary organisation and is not a statutory body regulating the profession. Its members are however expected to abide by the organisation's code of ethics which is available on our website.

IAIAsa is an Affiliate of IAIA which is an international body through a memorandum of understanding. IAIA is not responsible or liable for the actions or activities of the Affiliates. Membership of one does not imply membership of the other.

Any enquiries regarding this membership may be directed to the Secretariat at the above contact details.

Yours sincerely

Rethabile Mbokodi
President 2021/2022

28419660

University of Pretoria

The Council and Senate hereby declare that
at a congregation of the University the degree

Bachelor of Social Sciences Honours
in
Environmental Analysis and Management

with all the associated rights and privileges
was conferred on

Vumile Celiwe Dlamini

in terms of the Higher Education Act, 1997 and the Statute of the University

On behalf of the Council and Senate

C. de la Rey

Vice-Chancellor and Principal

On behalf of the Faculty of Humanities

Dean (Acting)

Registrar

2012-04-23

UNIVERSITY OF KWAZULU-NATAL

The Universities of Durban-Westville and Natal merged
to become the University of KwaZulu-Natal on 1 January 2004

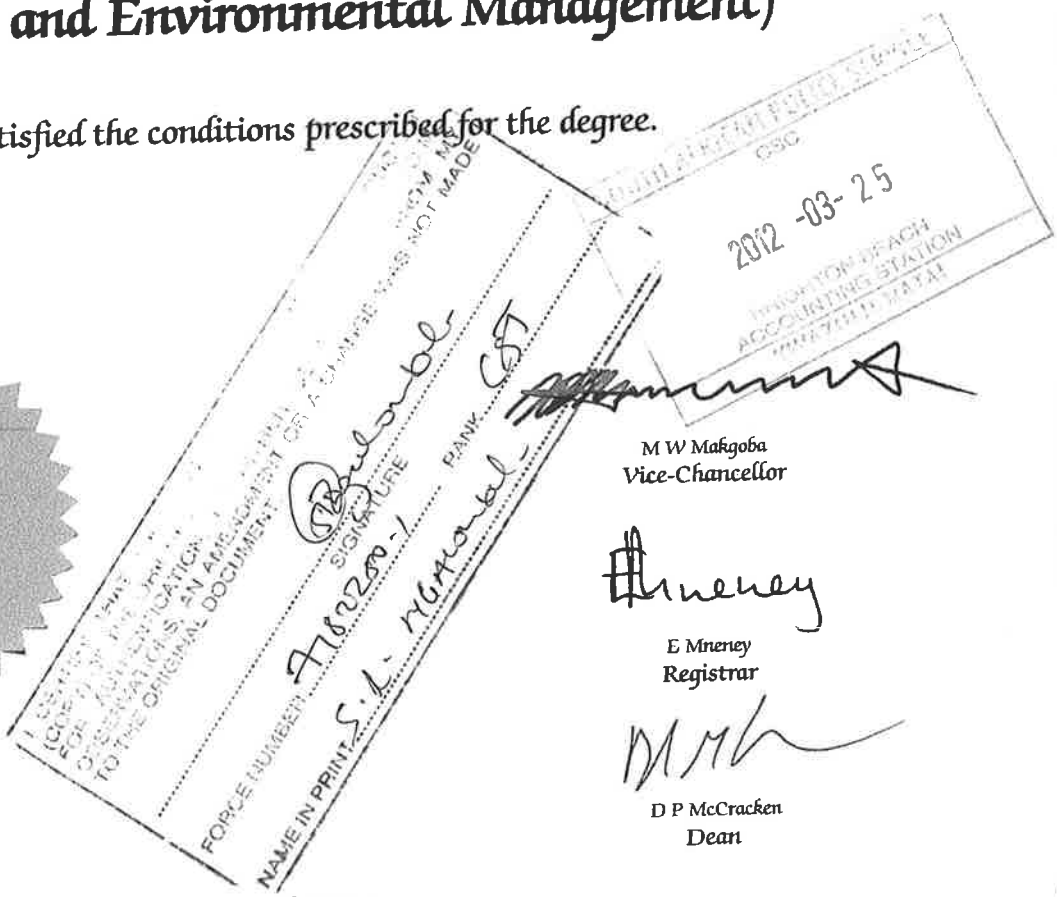
This is to certify that

Vumile Celiwe Dlamini

was admitted this day
at a congregation of the University
to the degree of

Bachelor of Social Science
(Geography and Environmental Management)

having satisfied the conditions prescribed for the degree.



M W Makgoba
Vice-Chancellor

E Mneney
Registrar

D P McCracken
Dean

23 April 2007

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA
Denkleiers • Leading Minds • Dikgopolo tša Dihlalefi

STUDENT NUMBER	28419660
SURNAME	Dlamini
FIRST NAMES	Vumile Celiwe
DATE OF BIRTH	1986-05-09
TYPE OF EXEMPTION	Gr 12 not required
DATE ISSUED	2012-02-23

LIST OF COURSES PASSED

2011 (Full-time)	Program: BSocSci Hons		Plan: Environmental Anal and Mngm	
Course offering	**Description**	**Academic progress unit**	**%**	**Decision result**
GGY 793	Geography of land reform 793	20	75	A- (Pass with distinction)
GGY 785	Env impact assess and man 785	20	68	B+ (Pass)
GGY 780	Urban geography of SA 780	20	75	A- (Pass with distinction)
GGY 729	Industrial environmental 729	20	78	A- (Pass with distinction)
GGY 727	Environmental compliance 727	20	68	B+ (Pass)
GGY 711	Environmental principles 711	20	75	A- (Pass with distinction)
GGY 703	Research and presen skills 703	10	68	B+ (Pass)
GGY 702	Geography Project 702	30	73	B+ (Pass)

Term percentage average: **72.81**
Cumulative Percentage Average: **72.81**

Outcome: Bachelor of Social Sciences Honours

The abovementioned student formally complied with all the requirements for the qualification: Bachelor of Social Sciences Honours on 2012-01-31 and this qualification will be conferred/issued on 2012-04-23

2012 (Full-time)	Program: BSocSci Hons		Plan: Environmental Anal and Mngm	
	In partial fulfilment of the requirements for Bachelor of Social Sciences Honours			
Course offering	**Description**	**Academic progress unit**	**%**	**Decision result**

Term percentage average: **0.00**
Cumulative Percentage Average: **72.81**

for **REGISTRAR**

OFFICE OF THE DEAN
FACULTY OF HUMANITIES
24 FEB 2012
STUDENTE ADMINISTRASIE
STUDENT ADMINISTRATION
UNIV VAN/OF PRETORIA

SOUTH AFRICAN POLICE SERVICE
2012 -03- 25

I CERTIFY THAT THIS IS A TRUE REPRODUCTION (COPY) OF THE ORIGINAL DOCUMENT. I FURTHER CERTIFY THAT FROM MY OBSERVATIONS, AN AMENDMENT OR A CHANGE WAS NOT MADE TO THE ORIGINAL DOCUMENT.
SIGNED
RANK
FORCE NUMBER 71627504
NAME IN PRINT S. R. NGALONDLU

University of Pretoria

Faculty of Natural and Agricultural Sciences

Centre for Environmental Studies

This is to certify that

VC Dlamini

has successfully completed the

Basic Training Course for Environmental Inspection

July to December 2011

Course Leader

General Manager: CES

Dikeledi Mokotong

Environmental Consultant

Curriculum Vitae

Niara Environmental Consultants (Pty) Ltd
Registration no.: 2012/018290/07
Cell: +27827672786; Fax: 0865314434
www.niara.co.za
info@niara.co.za

KwaZulu Natal Office:
59 Beaumont Road, Bluff,
Durban, 4052

Gauteng Office:
Office 1
Palm Place Office Park
22 Bram Fischer Drive,
Linden, Johannesburg, 2195

Mpumalanga Office:
16 Birkholtz Avenue,
Witbank Ext 16,
eMalahleni, 1034

Curriculum Vitae of Dikeledi Mokotong

Director: Environmental Management Services

Dikeledi Mokotong holds a Bachelor of Science Honours Degree in Environmental Management and has completed SAMTRAC. She has a certificate in Project Management obtained from the Business School of Varsity College.

Dikeledi is an Environmental Consultant with 7 years of experience within the field of Environmental, Health and Safety Management. Her focus areas include Environmental Management, Environmental and Safety Auditing, Environmental Impact Assessment (EIA), Environmental Sustainability, Project Management and Stakeholder Liaison. She has been fully engaged in the above in the capacity of Environmental Assessment Practitioner.

As an EAP who has a vast understanding of the National Environmental Management Act (Act 107 of 1998), Dikeledi has undertaken Environmental Impact Assessment (EIA) and Public Participation Processes (PPP) and procedures for various sectors and industries including agricultural, telecommunications, mining, renewable energy, construction etc. (both private and government) to assist in sustainable environmental management solutions and legal compliance.

Her role in previous environmental consulting organisations has exposed her to engagement and technical application of pollution mitigation strategies, Environmental Impact Assessments, Water Use License Application (WULA) administration, Waste Management Solutions, Audits and Water quality sampling. Through previous employment in the public sector processing and providing technical support for (EIA) final decisions in term of EIA Regulations within legislated timeframes has made her knowledgeable in the legislated requirements and procedures.

Office 1, Palm Place Office Park, 22 Bram Fischer Drive, Linden, Johannesburg 2195	
+27 (0) 83 342 0151	
dikeledi@niara.co.za	
Dikeledi Mokotong	

Key Competencies:

- Project Management
- Legal Compliance Audits: Environmental / Health & Safety
- Environmental Control Officer
- Performance Assessments (Environmental Audits) on mine EMPrs
- Compliance audits on environmental authorisations (e.g. ROD's, water, air and waste licenses)
- Environmental Impact Assessments
- Basic Assessment Reports
- Mineral Law -Mining Rights and Permits
- Environmental Authorisation Applications
- Water Use License Applications
- Co-ordinating and conducting Public Involvement processes.
- Social Assessment (Stakeholder and Social Analysis)
- Public Participation Process and Stakeholder consultation and mediation

Education:

- BSc. (Geography and Environmental Management) University of KwaZulu Natal (2012)
- BSc. Hons. (Environmental Management) University of South Africa (2019)
- Training in Waste Management (NQF 4, 2 &1) Interwaste Environmental Solutions (2018)
- Project Management The Business School at Varsity College (2016)
- Environmental Impact Assessment: A Practical Approach North West University: CEM (2015)

Language Skills:

- English (excellent)
- isiZulu (excellent)
- Sepedi (excellent)
- Setwana (excellent)

Employment:

- July 2022 – present: Environmental Consultant, Niara Environmental Consultants
- May 2017 – July 2019: Tshikovha Green and Climate Change Advocates
- April 2015 – March 2016: Department of Environmental, Forestry and Fisheries
- October 2014 – June 2016: Rev 2 Light
- October 2.013 – March 2015: Sbazela Environmental Solutions

Project Experience:

- The proposed establishment of a Macadamia Nut and Guava Orchard on Portion 10 of the Farm Unit Palmietfontein 2 LT within Makhado Local Municipality, Limpopo Province

- The Proposed Establishment of a Macadamia Nut Orchard on Farm Sutton Crest 11 In Makhado Municipality, Limpopo Province
- WULA for the Macadamia Nut Orchard on Farm Sutton Crest 11 In Makhado Municipality, Limpopo Province
- Environmental Performance Assessment for Assen Iron Ore Mine in Northwest Province (Audi
- The proposed development of a new Cemetery and associated infrastructure located within Portion 26 of the Farm Rietspruit 535IQ; situated in the Emfuleni Local Municipality, Gauteng Province
- Proposed Zinc Recovery Plant Located within the Existing EBM Projects (Pty) Ltd Facility, In Springs, Gauteng Province
- The proposed prospecting activities for phosphate and limestone on Portion 03, 04, 05, 06, 09, 10, 11, 15, 23, 36 of Farm Yzervarkensrug 127, the remaining extent of Farm 1139 and Portion 1 of farm 1139, in the Magisterial District of Vredenburg (Malmesbury) within Saldanha Bay Municipality, Western Cape Province
- The proposed Prospecting Right of Coal on farm Syferfontein 288 IR and Zeerkry 292 IR situated in Delmas within Nkangala Magisterial District, Mpumalanga Province
- The Proposed Construction of a 20m Vodacom Lamp Post Telecommunications Mast in Sekhaolelo on ERF 805 Mahwelereng-C Township within Mogalakwena Local Municipality, Waterberg District Municipality Limpopo Province.
- The unlawful commencement and continuation of listed activity in terms of Section 24 G for the Poultry Farm (Egg Production) and associated infrastructure, located on Portion 04 of Farm Unit Paarde Plaats 378 KR, in Modimolle within the Modimolle Local Municipality in the Jurisdiction of Waterberg District Municipality, Limpopo Province
- Social Impact Assessment for the Blesboklaagte S102 EA IWUL and WL
- Social Impact Assessment for the proposed Wonderhoek Open Cast Coal Mine near Middelburg, Mpumalanga Province
- Environmental Impact Assessment (EIA) and Water Use Licence Application for The Grootlaagte Opencast Mine Mining Right Application Situated in The Steve Tshwete Local Municipality, Nkangala District Municipality in Mpumalanga

- Community Health Impact Assessment for the proposed Wonderhoek Open Cast Coal Mine near Middelburg, Mpumalanga Province
- Rapid Appraisal Health Impact Assessment for the Proposed Platinum Pride Crematorium in Cape Town

UNISA

UNIVERSITY OF SOUTH AFRICA

We certify that

DIKELEDI GETRUDE KEAMOGETSOE MOKOTONG

having complied with the requirements of the Higher Education Act and the Institutional Statute, was admitted to the degree of

BACHELOR OF SCIENCE HONOURS

in Environmental Management

at a congregation of the University on 4 June 2019

Vice Chancellor

Executive Dean

University Registrar

1981025438413 3G05701

UN67018215A

UNIVERSITY OF KWAZULU-NATAL ™

INYUVESI YAKWAZULU-NATALI

This is to certify that

Dikeledi Getrude Keamogetsoe Mokotong

was admitted this day
at a congregation of the University
to the degree of

Bachelor of Science

(Geography and Environmental Management)

having satisfied the conditions prescribed for the degree.

M W Makgoba
Vice-Chancellor

J J Meyerowitz
Registrar

AT Modi
Dean

23 April 2013

209536286

108977

UV PROTECTED

CERTIFICATE

This is to certify that

DGK MOKOTONG

ID Number

900811 0329 087

has met the requirements for

SAMTRAC

the flagship in HSE training

Training Period

25/02/2019 - 08/03/2019

Elaine Herbst
Operational Manager

With Distinction

NOSA ★★★★★ iirsm APPROVED ORGANISATION STATUS Jun 2017 - Jun 2020 iosh SAQA

Cert No: 19/009687

BCT13

THE INDEPENDENT INSTITUTE OF EDUCATION

THE INDEPENDENT INSTITUTE OF EDUCATION CERTIFIES THAT

Keamogetsoe Dikeledi Mokotong

attended lectures at The Business School at Varsity College and successfully completed The Institute's assessment for the Short Learning Programme in

PROJECT MANAGEMENT

With Distinction

THE BUSINESS SCHOOL ·AT·VARSITY·COLLEGE·

FOR HEAD OF INSTITUTE

FOR CIBM

9008110329087

STUDENT ID NUMBER

15021167

STUDENT NUMBER

SPJMA01817161062928

CERTIFICATE NUMBER

25 July 2016

DATE

CIBM THE CHARTERED INSTITUTE OF BUSINESS MANAGEMENT

INTERWASTE
environmental solutions

CERTIFICATE OF COMPETENCE

This is to certify that

Dikeledi Mokotong
9008110329087

has successfully achieved competence against the

TRAINING IN WASTE MANAGEMENT
23 - 24 October 2017

aligned to

NQF Level 4 (16 Credits) - Unit Standard 123369

Unit Standard Title:

"Implement Environmental Improvements to a Site, Facility, Operation or Process"

NQF Level 4 (16 Credits)

accredited with the Local Government Sector Education Training Authority
By the South African Qualification Authority.

23.1.2018

Date of Issue

Rajas Pillay

LGSETA Accreditation No. LG 973 P
Issued without alteration or erasure as an original copy

SAQA LGSETA

Certificate Number
201814

NORTH-WEST UNIVERSITY ®
YUNIBESITI YA BOKONE-BOPHIRIMA
NOORDWES-UNIVERSITEIT

CEM

Centre for Environmental Management

This is to certify that

DGK MOKOTONG
9008110329087

successfully completed the short course on:

Environmental Impact Assessment: A Practical Approach

CEM-05.1/0014/2015
1-5 June 2015

Prof. JG Nel
Executive Manager:
Centre for Environmental Management
Course Leader

Prof. JJ Pienaar
Dean Faculty of Natural Science

environmental affairs
Department:
Environmental Affairs
REPUBLIC OF SOUTH AFRICA

SERVICE CERTIFICATE

This is to certify that

Ms Dikeledi Getrude Keamogetsoe

Mokotong

ID NO: 9008110329087

Participated and successfully completed an

Internship Program

in the Department of Environmental Affairs

01/04/2015 to 31/03/2016

Chief Director: HCM

Signature:

Date: 31/03/2016

REPUBLIC OF SOUTH AFRICA

National Senior Certificate

Awarded to

Dikeledi Getrude Keamogetsoe Mokotong

Identity number 9008110329087

Subjects	%	Achievement level
English Home Language	64	5
Sepedi First Additional Language	72	6
Mathematics	60	5
Life Orientation	85	7
Computer Applications Technology (25 W.P.M.)	70	6
Geography	69	5
Physical Sciences	54	4
**********	***	*

This candidate is awarded the National Senior Certificate and has met the minimum requirements for admission to bachelor's degree, diploma or higher certificate study as gazetted for admission to higher education, subject to the admission requirements of the higher education institution concerned.

With effect from December 2008

This certificate is issued without alteration or erasure of any kind.

090 7196 9732 X

Chief Executive Officer

UMALUSI

Council for Quality Assurance in General and Further Education and Training South Africa

(See reverse for more information)

THIS CERTIFICATE IS PRINTED ON WATERMARK PAPER - PLEASE HOLD UP TO THE LIGHT TO VERIFY