SAPREF NORTH FLARE REPLACEMENT PROJECT

BASIC ASSESSMENT REPORT

DRAFT

Image: SAPREF

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BASIC ASSESSMENT REPORT

SHELL AND BP SOUTH AFRICA PETROLEUM REFINERIES (SAPREF)

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WSP
BLOCK A, 1 ON LANGFORD
LANGFORD ROAD
WESTVILLE, DURBAN, 3629
SOUTH AFRICA

T: +27 31 240 8800
F: +086 606 7121
WSP.COM

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SIGNATURES

PREPARED BY

Digitally signed by Seed, Nigel (ZANS00325)
DN: cn=Seed, Nigel (ZANS00325), ou=Active, email=Nigel.Seed@wsp.com
Date: 2021.01.17 13:42:45 +02'00'

Nigel Seed
Director

REVIEWED BY

Digitally signed by Cope, Jenny (UKJEC004)
DN: cn=Cope, Jenny (UKJEC004), ou=Active, email=Jenny.Cope@wsp.com
Date: 2021.01.17 10:57:43 +02'00'

Jenny Cope
Associate

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PRODUCTION TEAM

CLIENT

Environmental Manger	Melanie Francis
Project Manager	Larissa Terdu-Smolders

WSP

Environmental Assessment Practitioner	Nigel Seed
Air Quality Specialist	Lisa Ramsay

EXECUTIVE SUMMARY

INTRODUCTION

Shell & BP South African Petroleum Refineries (SAPREF) located at Prospecton on the south coast of the eThekwini Municipality, is a joint venture between Shell Refining SA and BP Southern Africa.

SAPREF currently has two separate flares – one located at the northern side of the refinery (North Zone) and the other at the south side (South Zone). Flaring is an important operational and safety measure at SAPREF, particularly during non-routine operational periods such as malfunction or upset, to prevent the build-up of pressure in the refinery system. The main functions of flare systems are 1) the safe disposal of gas and liquids from depressurising process units during processing trips or upsets; 2) the safe disposal of gas and liquids from depressurising process units to prepare for the repair/maintenance of process equipment; and, 3) the safe disposal of gas and liquids from depressurising process units in emergencies.

Currently SAPREF can use the combined capacity of both flares in an integrated manner to flare from the North and South Zones of the refinery, i.e. if the pressure generated at North Zone exceeds the capacity of the North Flare, it could be flared in the South Flare. However, the current situation is not ideal nor a long-term solution, as these interconnecting lines will need to be isolated for unit shutdowns whilst the flares will still be in operation. Therefore, it is proposed to replace and upgrade the existing north flare. Further justification for the project includes the following:

1) The North Flare was installed in 1994 and has been operational for more than 26 years. Due to its age, prolonged safe and reliable operation beyond 2022 is not viable, even with extensive maintenance and repairs; therefore, the only option is to replace the flare with a new one.

2) SAPREF has implemented operational changes at the refinery to meet increasingly stringent fuel sulphur specifications. In particular, the replacement of the reactor in the hydrogen desulphurisation unit (Unit 4 / HDS4) has changed the flaring requirements of the refinery. SAPREF currently can meet this requirement by using the combined capacity of the North and South Flares; however, to reduce process and site risk, good practice requires that the flares should process full load without balancing. To achieve this, the capacity of the North Flare must be increased.

3) The flare replacement project is an opportunity for SAPREF to improve the environmental performance of the flare. The proposed replacement flare uses up-to-date technology, which will result in lower noise emission and improved combustion of potentially harmful gasses.

The proposed flare tip will be designed without refractory[1] which is according to the latest international flare tip design standard. SAPREF has investigated various options to ensure that heat radiation levels at the refinery boundary remain within international acceptable and safe limits, including *inter alia* controlling public access to the radiation zone, the use of shields and shelters, relocation of the flare, and increasing the flare height. The preferred option (that is assessed in the basic assessment (BA) report involves increasing the flare height from 59.3 m (existing flare) to at least 77 m (increase of 17.7 m).

SAPREF intends to submit an application for Environmental Authorisation to the Department of Economic Development, Tourism, and Environmental Affairs (EDTEA) for the proposed replacement and upgrading of the North Flare, which is an activity regulated in terms of the National Environmental Management Act (NEMA) 2014 Environmental Impact Assessment (EIA) Regulations, as amended.

[1] *Refractory is a heat resistant liner material used in the flare to prevent heat and chemical damage to the structure.*

Location of the North Flare within the SAPREF Refinery

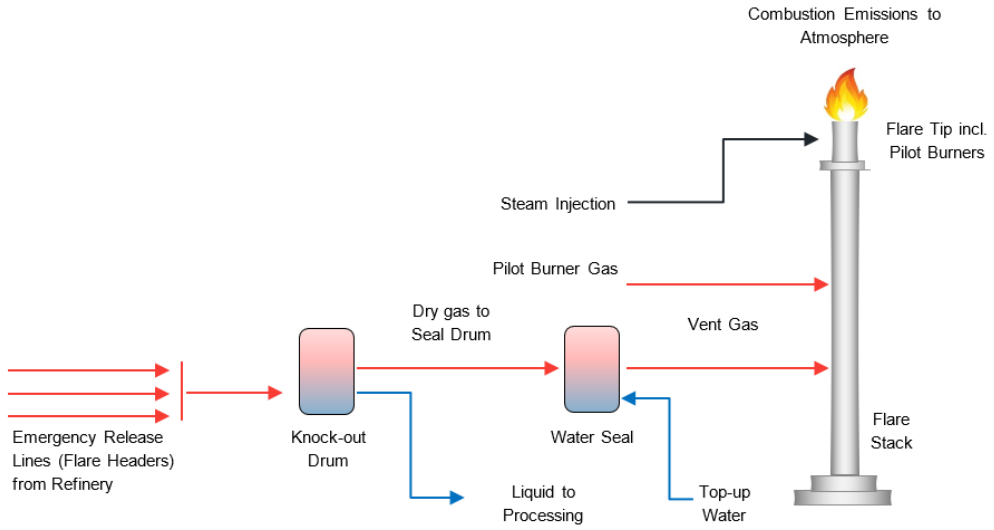
DESCRIPTION OF FLARING ACTIVITIES

Flaring is an important operational and safety measure at petroleum refining facilities, particularly during non-routine operational periods such as malfunction or upset, to prevent the build-up of pressure in the refinery system.

The main functions of flare systems are 1) the safe disposal of gas and liquids from depressurising process units during processing trips or upsets; 2) the safe disposal of gas and liquids from depressurising process units to prepare for the repair/maintenance of process equipment; and, 3) the safe disposal of gas and liquids from depressurising process units in emergencies.

Descriptions of the main flare system components are provided below.

- **Knock-out Drum**: Liquids that may be in the vent stream which can extinguish the flame or cause irregular combustion and smoking. In addition, flaring liquids can generate a spray of burning chemicals that could create a safety hazard. The removal of liquids is achieved by a knock-out drum, which condenses the liquid from the gas stream before combustion. The removed condensate is returned to the refinery process for hydrocarbon recovery.
- **Seal Drum**: The vent streams is passed through a liquid seal before going to the flare stack. The liquid seal prevents air from getting into the flare system, which could result in flame flashbacks (movement of the flame down into the stack).
- **Flare Stack**: The stack is used to elevate the flare to a height where the flame does not present a hazard to surrounding personnel and facilities.
- **Flare Tip**: The flare tip is designed to give environmentally acceptable combustion of the vent gas. The flare tip is normally proprietary in design. Consideration is given to flame stability, ignition reliability, and noise suppression. The flare tip includes the following subcomponents:
- **Gas Seal**: The gas seal is installed in the flare stack to prevent explosion risk caused by air flowing back into the flare stack due to wind or the thermal contraction of stack gases.
- **Pilot Burners**: To keep the flare system functional, a small amount of gas is continuously burned, like a pilot light, so that the system is always ready for its primary purpose as an over-pressure safety system.
- **Steam Injection**: Steam is injected into the flare tip to improve combustion and reduce formation from the pilot burners and the vent gas.



Flare Components

SUMMARY OF THE REGIONAL AND SITE ENVIRONMENTAL CONDITIONS

PHYSICAL ENVIRONMENT

Climate

Seasonal and diurnal pollutant concentration levels fluctuate in response to the changing state of atmospheric stability, to concurrent variations in mixing depth and to the influence of mesoscale and macroscale wind systems on the transport of atmospheric contaminants. Of relevance to the air quality aspects of the project, the BA report provides an overview of the atmospheric circulations influencing airflow and the subsequent dispersion and dilution of pollutant concentrations in the South Durban basin. The localised airflow in South Durban is described as a system of drainage winds that flow down the Umbilo and the Umhlatuzana valleys at night, across the alluvial flats at the head of the bay and up against the Bluff ridge. From here, the air is diverted between the Bluff and Berea ridges as gentle southwesterly winds towards Durban's central business district. The accumulation of cold air in the Durban South basin may lead to valley inversions at night, limiting vertical dispersion. This local wind pattern is regularly disrupted by the passage of coastal lows and westerly wave frontal systems that clear the boundary layer every three to five days during the winter months.

Air Quality

Ambient air quality monitoring data for particulate matter less than 10 micrometres in diameter (PM10), Nitrogen Dioxide (NO_2); and Sulphur Dioxide (SO_2), was sourced from three monitoring stations in the region, namely Wentworth, Ganges and Settlers. All stations are owned and managed by the eThekwini Metropolitan Municipality. Data for the period January 2017 – December 2019 was assessed for compliance with applicable National Ambient Air Quality Standards (NAAQS). Discretised results in the BA report variably show instances of compliance and non-compliance with the NAAQS at receptor locations, which is likely attributable to the industrialised nature of the south Durban basin and the meteorological conditions. These include exceedences for particulate matter less than 10 micrometres in diameter (PM10), Nitrogen Dioxide (NO_2), and Sulphur Dioxide (SO_2).

Ambient Noise

Baseline noise levels in the south Durban basin are generally elevated as a function of a wide range of sources including industrial operations (heavy machinery and equipment, loading and unloading of materials, operational processes, etc.) and road traffic (heavy vehicular and commuter traffic).

Geology and Soils

The South Durban basin area is underlain by recent alluvial soils and Quaternary sediments (Harbour Beds) flanked on both sides by aeolian sands of the Berea Formation. The local geological conditions below the Refinery Site are relatively variable, with both depth and lateral distribution. The bulk of the area is covered by fill material brought in during construction of the Airport, which comprises 1 to 2 meters of silty sands and clayey sands of

the Berea Formation. The fill is underlain by the Harbour Beds, which are a thick sequence of estuarine and lagoonal sediments, comprising predominantly sand with subordinate layers and lenses of clay.

Geohydrology (groundwater)

There are unconfined and semi-confined aquifer conditions beneath the site, due to the presence of a discontinuous shallow clay layer beneath portions of the Site. The elevation of the unconfined groundwater aquifer beneath the site ranges between approximately 1 and 6m above mean sea level (mamsl). The projected groundwater flow patterns indicate groundwater flow in the area is predominantly to the east, with a hydraulic gradient of approximately 1 in 300.

Topography

The site occurs in a relatively low-lying flat area that exists between the Bluff Coastal Dune to the east and Isipingo Hills to the west. This flat, former wetland area, previously incorporated the Durban Bay Harbour, and extended from the foreshore and Central Business District (CBD) area of Durban south to Isipingo and Prospecton. The Refinery site varies in elevation between approximately 3.0 and 6.0 mamsl, with an average elevation of approximately 4.0 mamsl over the Main Plant Area.

Hydrology (surface water)

In the south Durban basin, the general movement of surface water is in a northwesterly direction downslope into the basin and toward the man-made canals where it enters the Indian Ocean

Two rivers, namely the Isipingo and uMlazi River, are the main drainage features in the vicinity of the Refinery. The Isipingo River occurs to the south of the site. The associated Isipingo Estuary is regarded as “highly degraded” with poor water quality due to significant past modifications resulting in impoverished benthic invertebrate and fish communities.

The uMlazi Canal is situated between Merewent and the old Durban International Airport. The water flowing through the canal is of extremely poor quality with high phosphate loads and low oxygen levels.

BIOLOGICAL ENVIRONMENT

Fauna and Flora

The majority of the refinery areas comprise hard standing, process areas and maintained lawn does not provide suitable habitat for the majority of flora, fauna, and avifauna (birds). An ecological area of interest is however located adjacent to the refinery on the northern side near to where the North Flare is located. The vegetation in this area is characterised as coastal forest in good condition, containing very low infestation of invasive alien plant species.

There are eight wetland systems within a 500m radius of the Refinery. These systems appear to have formed part of a historical flood plain wetland that had been modified over time in order to make way for the development within the area. As a result, the system has been infilled in portions and segmented into smaller systems. Wetlands occurring on the northern portion within the potential area of influence of the project are W1 and W2 occurring c. 850m and c. 750m northwest of the North Flare respectively. Both of these wetlands are located up gradient of the Refinery site, as such they are hydrologically isolated from the refinery (i.e. any surface water flows from the refinery are not anticipated to enter to the wetland system).

HUMAN ENVIRONMENT

Socio-economic

According to the 2011 Census data, the refinery falls within with Ward 90 of the eThekwini Municipality and is adjacent to Ward 68. Both wards comprise a mixture of community and industrial areas, as well as the former Durban International Airport site. Demographics in both wards are characterised by largely Coloured, Indian and African populations. 3% of the population have no schooling, and 41% to 43% have high school qualifications. In 2011, of the population aged 16 to 65 years across Ward 68 and Ward 90, 38.4% and 45.4% were employed and 59.4% and 50.5% were unemployed. An analysis of personal income across Ward 68 and Ward 90 demonstrates that the number of people with no income is 47.41% and 57.46%, respectively.

Cultural and Heritage Aspects

The Refinery has been fully transformed from its natural state and due to its brownfield nature is unlikely to contain significant cultural heritage resources other than buildings older than 60 years – none of which are located in the project area.

Traffic and Site Access

Traffic volumes in the areas surrounding the SAPREF Refinery are highly variable, however the road infrastructure is well developed and the primary transportation routes do not pass through any residential areas. Key intersections assessed by SAPREF in previous EIA studies had ample spare capacity during both morning and afternoon peak periods; this is unlikely to have changed significantly in the interceding period due to low levels of development within the region.

SUMMARY OF SCOPING AND ENVIRONMENTAL IMPACT ASSESSMENT

SCOPING PROCESS

A scoping process was used to identify which interactions between the project components and environmental resources/receptors were likely to result in environmental impacts. This resulted in the 'scoping out' of the following impacts from the BA process:

Greenhouse Gas Emissions (operation)

During construction, there will be a negligible increase in direct and indirect GHG emissions associated with electricity usage and small fuel burning appliances (e.g. electrical generators). During operation, the replacement flare will not directly result in changes in GHG emissions from the refinery.

Noise (construction)

Construction activities will not be continuous in nature, with only some equipment active at any given time. Due to the relatively low noise levels and distances of the construction areas to the refinery boundary, no significant changes in noise levels are anticipated at the refinery boundary.

Hazardous Substances (operation)

The operational phase will not include the storage and/or handling of hazardous substances. No impacts are anticipated.

Waste Management (operation)

The only waste that has the potential to be generated is a small quantity of gas purge gas filters. Spent filters will be managed via existing SAPREF waste management procedures.

Major Accidental Hazards (MAH) (operation)

The refinery is designated as a MHI. In terms of the MHI Regulations, it is necessary to undertake a risk assessment at existing MHIs prior to all modifications due to the change in procedures and capacity.

The North Flare replacement project is not associated with any existing major hazard risk sources at the refinery. Whilst vent gas and MRG are both flammable substances, only minor changes to the pipework configurations will be made at the base of the flare; there will be no significant change in quantities. The proposed flare is designed according to API520 to ensure process safety. As a conservative safety feature, the MRG pipeline will be designed for much higher pressures than the actual MRG pressure.

Effluent Generation (construction)

No effluent will be generated during the construction phase.

Water Consumption (construction and operation)

Negligible quantities of water will be required for construction purposes (in relation to existing water consumption at the refinery).

During operation of the flare, the only water requirement for the flare is linked to steam supply. Based on the steam additional requirement the increase to current water consumption will be c. 0.02% which is considered marginal and not a significant water resource efficiency issue.

Change in Aesthetics (construction)

For the most part, the replacement flare will be assembled on the ground whilst the existing flare remains in operation; therefore, there will be no change in aesthetics during construction associated with the flare structure itself. The crane that will be utilised for lifting the new flare into position is likely to be visible from off-site viewpoints. However, due to the existing highly industrialised setting of the refinery, this will not constitute a significant change in aesthetic.

Light Emissions / Light Pollution (construction)

Construction activities will not involve the use of major light sources.

Traffic and Transportation (construction and operation)

Increased vehicular traffic during construction is likely to be associated only with the delivery of equipment and removal of waste materials for off-site disposal. The quantities of materials for the project are relatively small and loads will be intermittent; therefore, no significant increase road traffic is anticipated.

There is no traffic or transportation associated with the operational phase of the flare.

ASSESSMENT OF IMPACTS

Where the scoping process identified impact sources and potentially significant impacts, then the potential environmental impacts were described and the significance of the impact assessed. The assessment of impacts and mitigation evaluated the likely extent and significance of the potential impacts on identified receptors and resources against defined assessment criteria. Where possible, mitigation measures were proposed and the significance of the resultant impact (residual impact) was reassessed. The following section comprises a summary of the impact assessment:

Potential for chance finds of cultural heritage resources (construction)

Whilst no impacts are anticipated, it is nevertheless possible that a resource may be encountered during excavation activities, and therefore a chance find protocol has been included within the EMPr. The impact significance rating was assessed to be **Low (-)** reducing to **Very Low (-)** with mitigation.

Localised air quality deterioration due to dust emissions (construction)

The use of vehicles and equipment in the work areas and the contractor laydown area has the potential to generate dust emissions. With the exception of very windy conditions, these emissions are likely to be confined to the immediate area. The impact significance rating was assessed to be **Very Low (-)** irrespective of the proposed dust control mitigation measures.

Air quality impacts (operation)

The project will result in increases in emissions from the flare during flaring scenarios due to the increase of the flare design capacity. The increase in emissions has the potential to impact negatively (i.e. increase concentrations) of modelled pollutants at receptor locations.

The increase in the flare stack height will generally have the effect of improving the dispersion of emissions into the atmosphere. In isolation, this has the potential to impact positively; i.e. decrease concentrations of modelled pollutants at receptor locations.

In compliance with the air quality legislation, an atmospheric impact report (AIR) was carried out. The report is appended to the BA Report and is the principal reference for the impact assessment within the BA report. The overall environmental impact of the project considered both of the above mechanisms.

The CALPUFF model was used, which is the recommended Level 3 model in the *Modelling Regulations.* CALPUFF is a multi-layer, multi-species non-steady-state puff dispersion model, which can simulate the effects of time and space, as well as varying meteorological conditions on pollutant transport, transformation and removal.

The emissions from flaring events are non-continuous; therefore, the AIR was based on the assessment of air quality impacts during short-term events under the following scenarios:

1) **Worst-case emergency scenario** – Emergency depressurising of the HDS4 unit to a fire at the unit. The risk of this scenario is mitigated through process safety management where SAPREF focuses on design integrity (all design and build processes must ensure that risks are as low as reasonably practicable (ALARP)); technical integrity; and, operating integrity.

2) **Planned refinery shutdown** – a scheduled annual event wherein an entire process unit of the refinery is taken off stream for an extended period for maintenance.

The AIR modelled the potential change in concentrations of PM10, NO_2, SO_2, and Total Volatile Organic Compounds (TVOC) at receptor locations chosen due to their proximity to the study site including places where sensitive individuals may be impacted, such as residences, schools or medical facilities.

The AIR shows the potential for short-term SO_2 exceedances at sensitive receptors during flaring incidents at SAPREF. However, these occur when combining a conservative emission scenario with worst-case meteorological conditions, which is very improbable. It is more likely than not that a planned shutdown will occur during meteorological conditions that promote effective dispersion and do not result in ambient exceedances at sensitive receptors.

Importantly, the proposed increased height of the North Flare decreases the likelihood of exceedances at sensitive receptors, due to increased dispersion of emissions before reaching ground level.

Principally as a result of the low probability of the impact occurring, impact significance rating was assessed to be **Very Low (-)**.

Mitigation measures associated with worst case scenario flaring event includes ensuring project flare design mitigates risks to as low as reasonably practicable (ALARP); and, continuation of process safety management systems to be continued in order to reduce the risk unplanned unit downtime and unit trips which lead to unplanned flaring events.

Mitigation measures associated with planned refinery shutdown scenario includes reducing the frequency of planned flaring events by changing major shutdowns to a 4-year cycle post 2022.

Changes in off-site ambient noise levels due to flare sound power levels (operation)

The replacement flare will utilise up-to-date technology, which will result in lower noise emission than the existing flare. The replacement flare is therefore expected to reduce off-site ambient noise levels during the operational phase. The predicted change (reduction) in off-site ambient noise levels could not be calculated due to the absence of sound power level (SPL) data for the current North Flare. However, screening sound level propagation calculations based on an SPL of the proposed flare indicate that it will have a negligible have a negligible contribution to cumulative contributions at the refinery boundary. It was recommended that SAPREF maintains its existing noise monitoring programme in order to obtain confirmatory monitoring data regarding reduction in ambient noise levels during flaring events. The impact occurring, impact significance rating was assessed to be **Low (+)**.

Soil and groundwater contamination due to accidental spillage of small quantities hazardous substances (construction)

Construction activities have the potential to generate stormwater contaminated with sediment, and oil and grease from machinery. Construction activities also have the potential to result in the handling and storage of additional waste materials, which may be contaminated. There is potential for localised contamination of the soil due to accidental spills of hazardous substances outside of secondary containment. The impact significance rating was assessed to be **Very Low (-)**. Mitigation measures were recommended including spill and incident prevention and management actions.

Soil and Groundwater contamination associated with the handling of potential latent subsurface contamination (construction)

There is potential for the identification of latent (historical) subsurface contamination during construction related excavations; however, these will be very limited in nature. If excavated material is found to be contaminated and is not handled correctly, it would have the potential to cause occupational health and safety risks as well as environmental impacts on soil, groundwater and surface water. The impact significance rating was assessed to be **Very Low (-)**. Mitigation measures were recommended including confirmatory sampling to identify contamination; and, compliance with the South African waste management legislation, if contamination is present.

Soil and groundwater contamination associated with waste generation and handling (construction)

The construction process is anticipated to generate small quantities of typical general and hazardous waste streams including potential contaminants such as oil and grease. There is potential for minor/localised surface/groundwater and soil contamination due to inadequate waste handling. The impact significance rating was assessed to be **Very**

Low (-). Mitigation measures were recommended including provisions for waste segregation, storage and handling, and disposal.

Change in aesthetics from off-site viewpoints associated with the increase in flare height (operation)

The proposed flare will be 17.7m higher than the existing flare. This change is likely to be visible from off-site viewpoints including the nearby communities. There are various existing stacks of greater height and diameter to the replacement flare, including the existing South Flare that is c. 100m in height (i.e. more than the proposed height of the new flare). Therefore the proposed increase in flare height does not constitute a significant change in aesthetic and is unlikely to result in any negative effects to off-site persons including the nearby communities. The impact significance rating was assessed to be **Very Low (-)**.

Light pollution associated with increase light emissions from the flare flame (operation)

The increased capacity of the flare will also result in an increase in the size, and consequently the amount of light emitted from the flame, resulting in a potential for light pollution. Light pollution effects typically include nuisances in nearby community areas when light intrudes into bedroom windows, upward light resulting in sky glow) and glare when intense light sources are viewed directly. A literature review as part of the BA process indicated that the luminosity associated with refinery flares is not identified as a significant impact associated with petroleum refineries. In addition to the above, the suburban community and industrial areas surrounding the refinery are intrinsically bright environments due to existing artificial light sources (street lights, mast lighting, industrial lighting etc.) and are therefore unlikely be sensitive to changes in light levels (albeit that significant changes are not expected in the case of the current project).

The absence of community complaints associated with light pollution from the refinery during the 2015 – 2020 (September) period indicates that this is not an existing issue that could be exacerbated by the project.

The impact significance rating was assessed to be **Very Low (-)**. It was recommended that SAPREF maintains its complaints register as a grievance mechanism for identifying any future light pollution issues.

Indirect employment opportunities within contracting firms (construction)

The project will create limited indirect employment opportunities within contracting firms in the construction phase. These may lead to improvement in the financial income and potential for improved living standards of employed individuals and households. The impact significance rating was assessed to be **Moderate (+)**. Mitigation measures were recommended including the prioritisation of local businesses contractors and labour throughout the construction phase, where feasible.

CONCLUSION

The overall objective of the BA process was to provide sufficient information to enable informed decision-making by the authorities. This was undertaken through consideration of the proposed project components, identification of the aspects and sources of potential impacts and subsequent provision of mitigation measures.

The BA process has found that both construction and operational phases of the proposed project will involve activities, which will lead to a limited number of direct and indirect impacts (negative and positive) on the biophysical and socio-economic environment. These impacts were found to vary in terms of their consequence and probability. Where appropriate, mitigation measures to reduce the negative impacts, and enhance positive impacts have been proposed, and detailed in the Environmental Management Programme Report (EMPr). Both the initial and residual (post-mitigation) significance of impacts were assessed so as to obtain an indication of the effectiveness of the mitigation measures.

All negative potential environmental and social impacts associated with the project have been assessed as having very low significance (residual i.e. assuming that mitigation is implemented). In addition, the project will result in positive impacts in terms of off-site ambient noise levels and local economic opportunities.

It is the opinion of WSP that the project should be authorised; and, that information contained in this BA Report is sufficient for an informed decision to be made.

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APPENDICES

1 INTRODUCTION

1.1 BACKGROUND

Shell & BP South African Petroleum Refineries (SAPREF) located at Prospecton on the south coast of the eThekwini Municipality, is a joint venture between Shell Refining SA and BP Southern Africa. The SAPREF Refinery located within the South Durban Basin has been in operation for over 50 years and is the largest crude oil refinery in sub-Saharan Africa. The refinery's products include: gasoline (petrol); paraffin; gasoil (diesel); solvents; jet fuel; bitumen; lubricating oil; liquid petroleum gas; marine fuel oil; and chemical feed stocks.

SAPREF currently has two separate flares – one located at the northern side of the refinery (North Zone) and the other at the south side (South Zone). Currently SAPREF can use the combined capacity of both flares in an integrated manner to flare from the North and South Zones of the refinery, i.e. if the pressure generated at North Zone exceeds the capacity of the North Flare, it could be flared in the South Flare. However, the current situation is not ideal nor a long term solution, as these interconnecting lines will need to be isolated for unit shutdowns whilst the flares will still be in operation. Therefore it is proposed to replace and upgrade the existing north flare. Further justification for the project includes the following:

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SAPREF intends to submit an application for Environmental Authorisation to the Department of Economic Development, Tourism, and Environmental Affairs (EDTEA) for the proposed replacement and upgrading of the North Flare, which is an activity regulated in terms of the National Environmental Management Act (NEMA) 2014 Environmental Impact Assessment (EIA) Regulations, as amended.

1.2 PURPOSE OF THE BASIC ASSESSMENT PROCESS

The Basic Assessment (BA) process is a simplified version of what may broadly be referred to as the environmental and social impact assessment (ESIA) process. It applies to activities contained in Listing Notice 1

[2] *Refractory is a heat resistant liner material used in the flare to prevent heat and chemical damage to the structure.*

of the EIA Regulations that are considered to have a relatively lower environmental impact than those contained in Listing Notice 2 (requiring a Scoping and Environmental Impact Assessment).

The BA process is an interdisciplinary procedure to ensure that environmental considerations are included in decisions regarding projects that may impact the environment. The process helps identify the possible environmental effects of a proposed activity and how those impacts can be mitigated. In the context of this report, the purpose of the BA process is to inform decision-makers and the public of the environmental consequences of the proposed project. This document (the BA report) is a technical tool that identifies, predicts, and analyses impacts on the physical environment, as well as social, cultural, and health impacts. The report identifies alternatives and mitigation measures to reduce the environmental impact of the proposed project; it also serves an important procedural role in the overall decision-making process by promoting transparency and public involvement.

Stakeholder engagement is a fundamental part of the BA process and aims to include potential Interested and Affected Parties (I&APs) in the process by notifying them of the proposed project. The stakeholder engagement process was initiated in May 2019. The process employed a number of techniques to establish contact and raise awareness amongst stakeholders with reference to the application. The objectives of the stakeholder engagement process are to:

- Ensure an open and transparent BA and consultation process;
- Enable stakeholders to register their interest and provide input into the BA process and share information; and,
- Ensure that all relevant issues are addressed as part of the BA process.

A Stakeholder Engagement Report (SER) is included in **Appendix A** of this report **, detailing the project's compliance with the public participation requirements of the EIA Regulations.

** *Note that the SER is only included in the final BA report for submission to the Authorities.*

1.3 ENVIRONMENTAL ASSESSMENT PRACTIONER

WSP Environmental (Pty) Ltd (WSP) has been appointed in the role of Independent Environmental Assessment Practitioner (EAP) to undertake the BA process for the proposed project. **Table 1** outlines the details of the EAP and his expertise.

Table 1: Details of the Environmental Assessment Practitioner

NAME OF CONSULTANT: **WSP ENVIRONMENTAL (PTY.) LTD.**

Contact Person:	Nigel Seed
Postal Address:	1st Floor Pharos House 70 Buckingham Terrace Westville Durban 3629 South Africa
Telephone:	031 240 8860
Fax:	031 240 8861
E-mail:	Nigel.Seed@wsp.com

Expertise to conduct this EIA	Nigel has 19 years' environmental and social consulting experience. Nigel has led complex Environmental and Social Assessments (ESA) and transaction related due diligence assessments across a range of sectors including aerospace, agro-processing, chemicals, healthcare, infrastructure (ports, roads, waste management), manufacturing, mining and beneficiation, oil & gas, pulp & paper power generation (thermal & renewables), and property development.

The EAP Curriculum Vitae is attached in **Appendix B.**

1.4 BASIC ASSESSMENT REPORT STRUCTURE

For the purposes of demonstrating legal compliance, **Table 2** cross-references the sections within the BA Report with the requirements as per Appendix 1 of the EIA Regulations (GNR 326 of 2017).

Table 2: Legislation Requirements as detailed in Appendix 1 of GNR 326

APPENDIX 4	LEGISLATED REQUIREMENTS AS PER THE NEMA GNR 326	SECTION
(a)	details of-	
	(i) the EAP who prepared the Environmental Management Programme (EMPr); and	Section 1.3 and Appendix B
	(ii) the expertise of that EAP to prepare an EMPr, including a curriculum vitae;	
(b)	the location of the activity, including:	Section 1.5
	(i) the 21 digit Surveyor General code of each cadastral land parcel;	
	(ii) where available, the physical address and farm name;	
	(iii) where the required information in items (i) and (ii) is not available, the coordinates of the boundary of the property or properties;	
(c)	a plan which locates the proposed activity or activities applied for as well as associated structures and infrastructure at an appropriate scale; or, if it is—	Figure 3
	(i) a linear activity, a description and coordinates of the corridor in which the proposed activity or activities is to be undertaken; or	N/A
	(ii) on land where the property has not been defined, the coordinates within which the activity is to be undertaken;	N/A
(d)	a description of the scope of the proposed activity, including— (i) all listed and specified activities triggered and being applied for; and (ii) a description of the activities to be undertaken including associated structures and infrastructure;	Section 1.6 and 3.1
	(i) planning and design;	Section 2.2
	(ii) pre-construction activities;	
	(iii) construction activities;	
	(iv) rehabilitation of the environment after construction and where applicable post closure; and	
	(v) where relevant, operation activities;	

(e)	(e) a description of the policy and legislative context within which the development is proposed including—	Section 1.6
	(i) an identification of all legislation, policies, plans, guidelines, spatial tools, municipal development planning frameworks, and instruments that are applicable to this activity and have been considered in the preparation of the report; and	
	(ii) how the proposed activity complies with and responds to the legislation and policy context, plans, guidelines, tools frameworks, and instruments;	
(f)	a motivation for the need and ability for the proposed development including the need and desirability of the activity in the context of the preferred location;	Section 2.3
(g)	a motivation for the preferred site, activity and technology alternative;	Section 3
(h)	a full description of the process followed to reach the proposed preferred alternative within the site, including —	
	(i) details of all the alternatives considered;	
	(ii) details of the public participation process undertaken in terms of regulation 41 of the Regulations, including copies of the supporting documents and inputs;	To be provided in Final BA Report on completion of the PP Process
	(iii) a summary of the issues raised by interested and affected parties, and an indication of the manner in which the issues were incorporated, or the reasons for not including them;	
	(iv) the environmental attributes associated with the alternatives focusing on the geographical, physical, biological, social, economic, heritage and cultural aspects;	Section 4
	(v) the impacts and risks identified for each alternative, including the nature, significance, consequence, extent, duration and probability of the impacts, including the degree to which these impacts— (aa) can be reversed; (bb) may cause irreplaceable loss of resources; and (cc) can be avoided, managed or mitigated;	Section 6
	(vi) the methodology used in determining and ranking the nature, significance, consequences, extent, duration and probability of potential environmental impacts and risks associated with the alternatives;	Appendix E
	(viii) the possible mitigation measures that could be applied and level of residual risk;	Section 6
	(ix) the outcome of the site selection matrix;	Section 3
	(x) if no alternatives, including alternative locations for the activity were investigated, the motivation for not considering such; and	
	(xi) a concluding statement indicating the preferred alternatives, including preferred location of the activity;	
	(vii) positive and negative impacts that the proposed activity and alternatives will have on the environment and on the community that may be affected focusing on the geographical, physical, biological, social, economic, heritage and cultural aspects;	Section 6
(i)	a full description of the process undertaken to identify, assess and rank the impacts of the activity will impose on the preferred location through the life of the activity, including—	Section 6
	(i) a description of all environmental issues and risks that were identified during the environmental impact assessment process; and	Section 6

	(ii) an assessment of the significance of each issue and risk and an indication of the extent to which the issue and risk could be avoided or addressed by the adoption of mitigation measures.	Section 6

1.5 PROJECT LOCATION

The location of the project is shown in **Figure 1** - **Figure 3**. **Table 3** provides the required cadastral information for the proposed project, in terms of Annexure 1(3) of GN.R326.

Table 3: Cadastral Information

SITE LOCATION DETAILS SS PER GN.R326 ANNEX 1 (3)

(i) 21 digit Surveyor General code of each cadastral land parcel:	NOFT00000001739200002 NOFT00000001739200003 NOFT00000001739200001
(ii) Physical address and farm name:	Refinery Road, Prospecton, Durban — Rem. Of Portion 2 of Inhlanzi No. 17382 — Portion 3 of Inhlanzi — Portion 1 of Inhlanzi No 17392
iii) Where the required information in items (i) and (ii) is not available, the coordinates of the boundary of the property or properties	Not required.

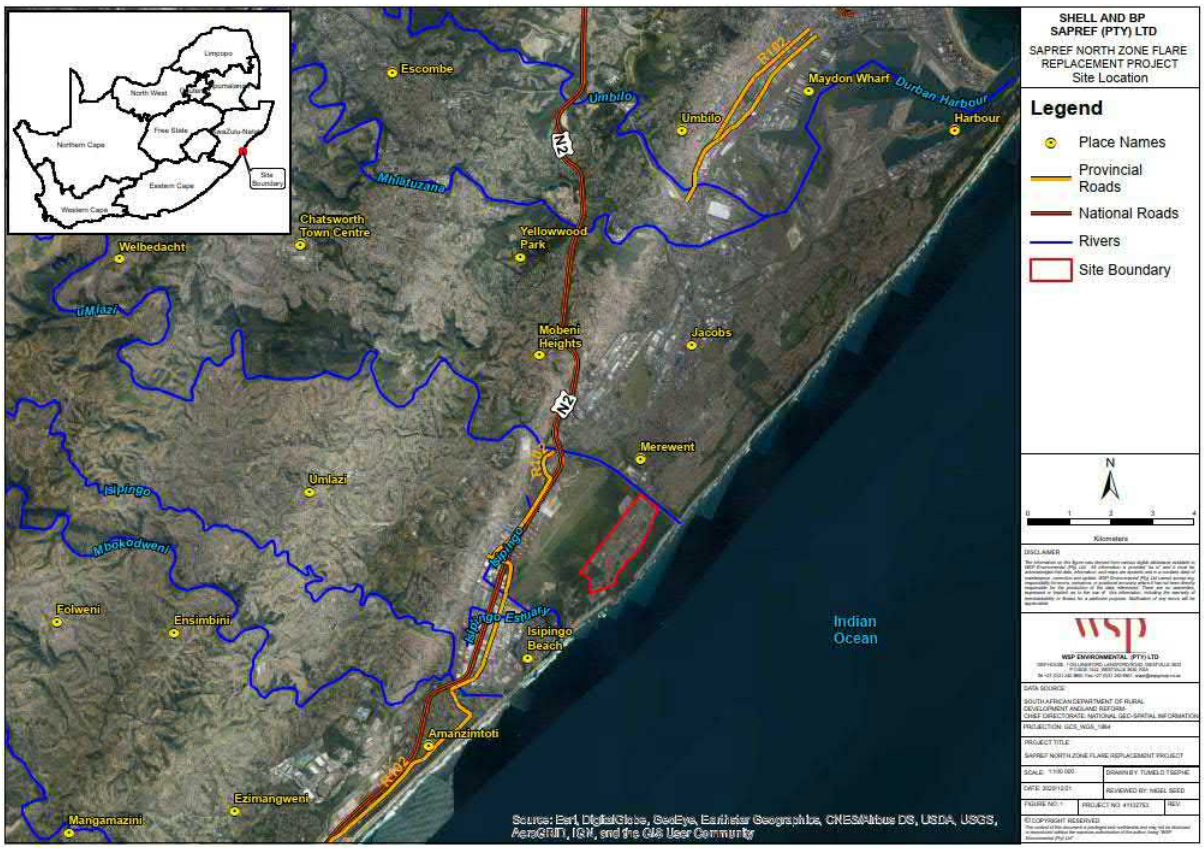


Figure 1: Regional location of the proposed project in KwaZulu-Natal

Figure 2: Location of the North Flare within the SAPREF Refinery

Figure 3: Location of the North Flare within the SAPREF Refinery (Small Scale)

1.6 POLICY AND LEGAL CONTEXT

The project will be carried out with due regard to South African legal requirements. **Table 4** identifies of all legislation potentially applicable to the project.

Table 4: Summary of National Legislation Applicable to the Project

TITLE OF LEGISLATION, POLICY OR GUIDELINE	APPLICABILITY TO PROJECT
NEMA (No. 107 of 1998)	**GN. R.983 (2014) as amended: Listing Notice 1: List of Activities and Competent Authorities Identified in terms of Sections 24(2) and 24d (as amended by GN. R327 (2017)** ***GN. R327 (Listing Notice 1) (34): The expansion of existing facilities or infrastructure for any process or activity where such expansion will result in the need for a permit or licence or an amended permit or licence in terms of national or provincial legislation.*** Applicable – the project will require an amendment to the existing Atmospheric Emission License (AEL) (see relevant section below).
National Environmental Management, Waste Act (No 59 of 2008)	**GN. R.921 (2013): List of Waste Management Activities that Have, or are Likely to Have, a Detrimental Effect on the Environment** Not Applicable.
National Environmental Management, Air Quality Act (No 39 of 2004)	**GN. R.893 - List of Activities requiring an AEL** ***SAPREF is currently in possession of an AEL (Ref: AEL003/S3), issued by the eThekwini Municipality, on 1 April 2017 and valid for five years (due for renewal not later than 1 October 2021).*** The conditions that would necessitate an amendment of the AEL are dealt with in Section 4 of the AEL (General Conditions) / 4.1 (Process and Ownership Changes) by provision of the following clauses: - Any changes in processes or production increases, by the license holder, will require prior approval by the licensing Authority. (This condition will not be imposed for what the Licensing Authority regards as minor changes where there will be insignificant impacts on the environment). - Any changes to the type and quantities of input materials and products, or to production equipment and treatment facilities will require prior approval by the licensing Authority. The project will require an AEL amendment due to a change in production equipment.
The National Water Act, (No 36 of 1998)	**Section 21 - Water uses for which a Water Use License (WUL) or General Authorisation is required.** Freshwater habitats (wetland and riparian systems) are present at and surrounding the SAPREF refinery however these are not located within a 500m radius area of the project. Moreover the project is located within the contained stormwater management system at the refinery and is therefore hydraulically isolated from these wetland areas. Comment from the Department of Water and Sanitation (DWS) on the absence of any WUL requirements for the project will be requested as part of the stakeholder engagement process.

Occupational Health and Safety Act (No 85 of 1993)	**GN. R.692 (2001): The Major Hazard Installation Regulations (MHI Regulations)** The refinery is designated as a MHI. In terms of the MHI Regulations it is necessary to undertake a risk assessment at existing MHIs prior to all modifications due to the change in procedures and capacity. The flare project is not associated with any existing major hazard risk sources at the refinery therefore a risk assessment is not required.
National Heritage Resources Act, 1999, (Act No. 25 of 1999)	***A cultural heritage impact assessment is required for projects at locations where there are culturally or historically significant elements including archaeological or palaeontological sites, on or within 20m of the site.*** The refinery and project development area has been fully transformed from its natural state and due to its brownfields nature is unlikely to contain significant cultural heritage resources other than buildings older than 60 years. The project does not involve the demolition of such dated structures. An exemption application will be submitted to AMAFA requesting exemption from need to undertake a Heritage Impact Assessment during the BA for the above-mentioned reasons.

2 PROJECT DESCRIPTION

2.1 GENERAL OVERVIEW OF SAPREF REFINERY

Crude oil is imported to the SAPREF refinery from countries in the Middle East and Africa by tankers. The oil is discharged at the single buoy mooring situated approximately 2.5 kilometres offshore from the Refinery. The crude oil enters the refinery through an underground pipeline, stored in tanks, and then fed into the refinery. The purpose of the refining process carried out at SAPREF is to convert crude oil into useful saleable products which are used as fuels for vehicles and other forms of transport; combustion fuel for the generation of heat and power; raw materials for the petrochemical and chemical industries; speciality products such as lubricating oils; and energy as a by-product in the form of steam and electricity. SAPREF currently makes 10 main products in 46 different grades, these include petrol, diesel, jet fuel, lubricating oil, liquid petroleum gas, paraffin, solvents, bitumen, and marine fuel oil (MFO).

The refining process at SAPREF can be separated into two phases and a number of supporting operations. Activities carried out in the primary stage of the refining process (Fractionation) are summarised below (www.sapref.com, 2012):

Fractionation: - The crude oil is first treated to remove bottom sediment including water soluble salts, sand, silt, rust and other solids. The oil is then separated into components (known as fractions) in distillation columns. The heaviest fractions condense at the hottest temperatures near the bottom of the distillation column and provide feedstock for the making of bitumen. Fractions condensing around the middle of the column include kerosene for jet fuel and gas oil for heating and diesel engines. The lightest fractions condense in the coolest temperatures near the top of the distillation column and include products such as propane, butane and naphtha (**Figure 4**).

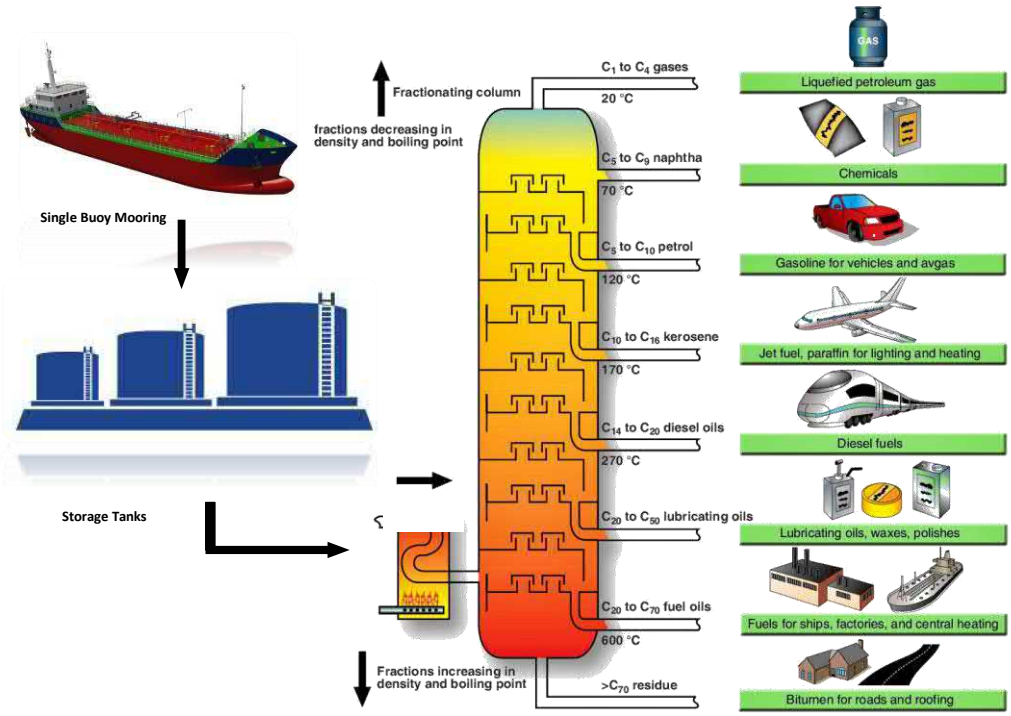


Figure 4: Simplified Schematic - Crude Import, Fractionation, and Product Uses

The second stage of the refining process (conversion stage) includes a complex arrangement processes which combine, break and reshape the fractions produced in the distillation process into higher quality petroleum products. The main processes that SAPREF carries out within this stage include:

- **Desulphurisation**: - the primary removal of sulphur from the petroleum streams and its conversion to elemental sulphur by-products;
- **Catalytic reforming**: - the upgrading of low-quality intermediate oil streams using various catalytic reforming processes;
- **Cracking**: - the conversion of heavy oil fractions from the distillation process into lighter petroleum products using heat and catalysts; and
- **Treatment**: - chemical treatment in order to meet product specifications for regulated substances (e.g. benzene and sulphur); as well as for the improvement of product odour and corrosivity. Typical treatment processes include butyl/butylene treatment, mercaptan (odorous sulphur species') oxidation, and alkylation.

Supporting operations are those not directly involved in the production of petroleum products, but serving in a supporting role. At SAPREF these include heat generation, waste water treatment, additive production, waste gas treatment, blowdown systems handling, blending of products, and storage of products.

2.2 DESCRIPTION OF FLARING ACTIVITIES

Flaring is an important operational and safety measure at petroleum refining facilities, particularly during non-routine operational periods such as malfunction or upset, to prevent the build-up of pressure in the refinery system.

The main functions of flare systems are 1) the safe disposal of gas and liquids from depressurising process units during processing trips or upsets; 2) the safe disposal of gas and liquids from depressurising process units to prepare for the repair/maintenance of process equipment; and, 3) the safe disposal of gas and liquids from depressurising process units in emergencies.

Descriptions of the main flare system components are provided below / summarised in **Figure 5**.

- **Knock-out Drum**: Liquids that may be in the vent stream which can extinguish the flame or cause irregular combustion and smoking. In addition, flaring liquids can generate a spray of burning chemicals that could create a safety hazard. The removal of liquids is achieved by a knock-out drum, which condenses the liquid from the gas stream before combustion. The removed condensate is returned to the refinery process for hydrocarbon recovery.
- **Seal Drum**: The vent streams is passed through a liquid seal before going to the flare stack. The liquid seal prevents air from getting into the flare system which could result in flame flashbacks (movement of the flame down into the stack).
- **Flare Stack**: The stack is used to elevate the flare to a height where the flame does not present a hazard to surrounding personnel and facilities.
- **Flare Tip**: The flare tip is designed to give environmentally acceptable combustion of the vent gas. The flare tip is normally proprietary in design. Consideration is given to flame stability, ignition reliability, and noise suppression. The flare tip includes the following subcomponents:
- **Gas Seal**: The gas seal is installed in the flare stack to prevent explosion risk caused by air flowing back into the flare stack due to wind or the thermal contraction of stack gases.
- **Pilot Burners**: To keep the flare system functional, a small amount of gas is continuously burned, like a pilot light, so that the system is always ready for its primary purpose as an over-pressure safety system.
- **Steam Injection**: Steam is injected into the flare tip to improve combustion and reduce formation from the pilot burners and the vent gas.

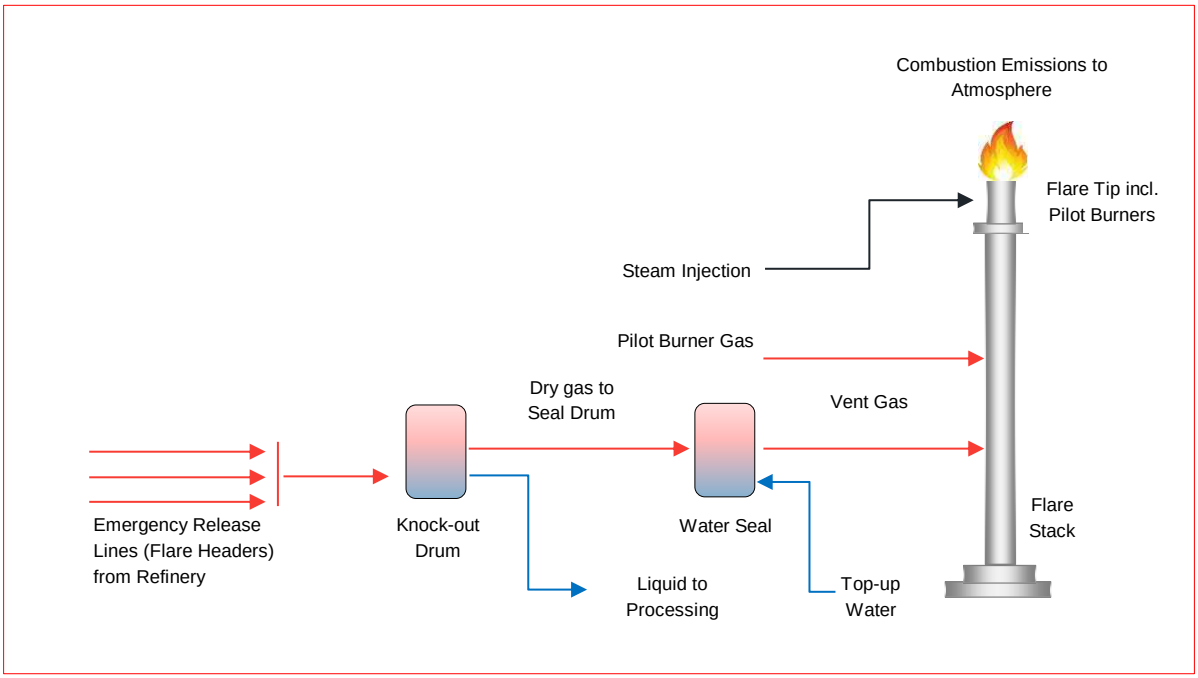


Figure 5: Flare Components

2.3 PROJECT JUSTIFICATION (NEED AND DESIRABILITY)

SAPREF currently has two separate flares – one located at the northern side of the refinery (North Zone) and the other at the south side (South Zone). It is possible that SAPREF can use the combined capacity of both flares in an integrated manner to flare from the North and South Zones of the refinery, i.e. if the pressure generated at North Zone exceeds the capacity of the North Flare, it could be flared in the South Flare.

SAPREF has identified the following justification for replacing the North Flare

1) The North Flare was installed in 1994 and has been operational for more than 26 years. Due to its age, prolonged safe and reliable operation beyond 2022 is not viable even with maintenance and repairs; therefore the only option is to replace the flare with a new one.
2) The interconnecting lines between the North Flare and the South Flare will need to be isolated for unit shutdowns. As flaring capacity is a safety feature at the refinery this would result in increased risk to the site.
3) SAPREF has implemented operational changes at the refinery to meet increasingly stringent fuel sulphur specifications. In particular, the replacement of the reactor in the hydrogen desulphurisation unit (Unit 4 / HDS4) has changed the flaring requirements of the refinery. SAPREF currently can meet this requirement by using the combined capacity of the North and South Flares; however the flares should be able to achieve full load without balancing. To achieve this, the capacity of the North Flare must be increased.
4) The project is an opportunity for SAPREF to improve the environmental performance of the existing North Flare. The replacement uses up-to-date technology, which will result in lower noise emissions and the improved combustion of potentially harmful gasses.

2.4 DESCRIPTION OF THE FLARE REPLACEMENT PROJECT

The North Flare system consists of a knockout drum, a seal drum, a flare stack, and a flare tip including an ignition system and three pilot burners. The project will replace the stack and the flare tip including the ignition system, steam injection system, and pilot burners. Each of these components of the replacement project are described below.

The existing knockout drum and seal drum do not require replacement or upgrading and will be retained. It is noted that mitigation against air being drawn into the stack itself will be provided by a constant purge ** of fuel gas or MRG immediately downstream of the seal drum as part of a different project (the Flare Risk Mitigation Project, J09).

*** A small quantity of purge gas is needed to prevent air being drawn into the stack which can create a flashback situation (explosion within the stack). The purge moves up the stack and is burned by the burners/pilots.*

An elevation drawing and 3D (isometric) render of the proposed flare structure is shown in **Figure 6**.

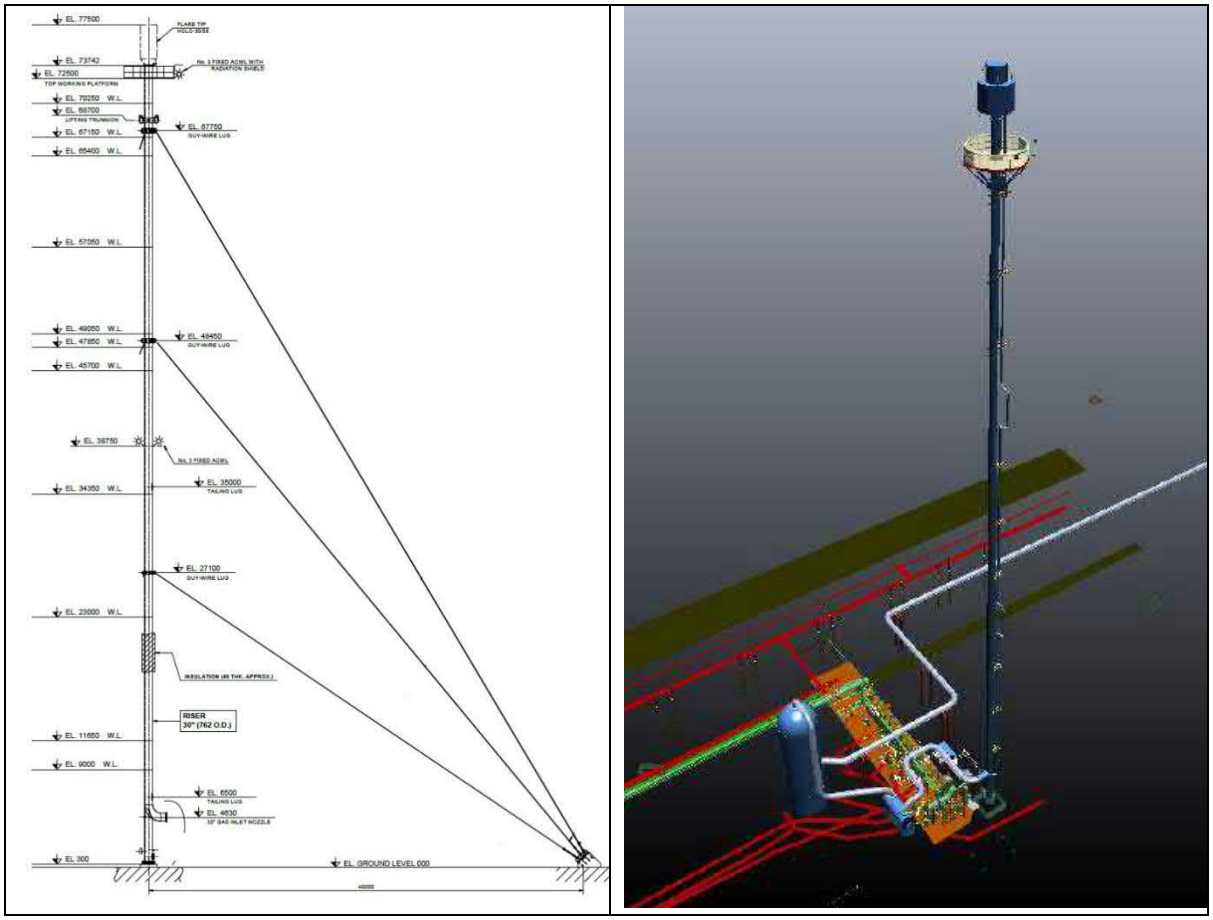


Figure 6: Elevation drawing of the proposed Flare Structure

2.4.1 PROPOSED LOCATION

The replacement flare will be constructed 5m north from the old flare. This is to minimize downtime by allowing most of the ground-works construction of the new flare whilst the old flare is still in operation. The

new flare will be lifted only when the old flare is non-operational, as it is not possible to work above ground-level whilst the old flare is in operation.

2.4.2 PROPOSED FLARE STACK

FLARE STACK CONSTRUCTION

The following three flare stack constructions are typically considered for refinery flares:

1) **Free-standing flares** provide ideal structural support. However, for very high units the costs increase rapidly. In addition, the foundation required and nature of the soil must be considered.
2) **Derrick-supported flares** can be built as high as required since the system load is spread over the derrick structure. This design provides for differential expansion between the stack, piping, and derrick. Derrick-supported flares are the most expensive design for a given flare height.
3) The **guy-supported flare** is the simplest of all the support methods. However, a considerable amount of land is required since the guy wires are widely spread apart. A rule of thumb for space required to erect a guy-supported flare is a circle on the ground with a radius equal to the height of the flare stack.

The current flare is a combination of derrick and guy wire supported constructions. The derrick construction requires maintenance which is not possible to do while the flare is in active service, therefore SAPREF has selected a guy supported flare construction for the new flare. Another advantages of the guy supported flare is that it minimizes the requirement for new supporting structures.

FLARE STACK HEIGHT

The flame generated by the burning of vent gas emits heat which is mostly carried upward into the atmosphere by convection. A smaller part of the heat is converted into radiation which is emitted into to the surroundings. In order to ensure that workers and the public are not exposed to unsafe heat radiation levels the height of the flare stack was designed based on Shell Standard DEP 80.45.10.10-Gen which specifies radiation limits applicable to various receptors or locations. The relevant limits applicable to the design of the project included:

1) **Property Limit**: 3.15kW/m^2 (1000 BTU) at the SAPREF property limit fence line where there is no access control and therefore potential for non-continuous public exposure.
2) **Sterile Area**: 6.30 kW/m^2 at 38 metres (2000 BTU) in the controlled area at the base of the flare where the maximum short-term exposure to radiant heat intensity is limited to 30 seconds. The corrugated plate interceptor (CPI) [oil water separation facility] is also required to be outside of the sterile area.

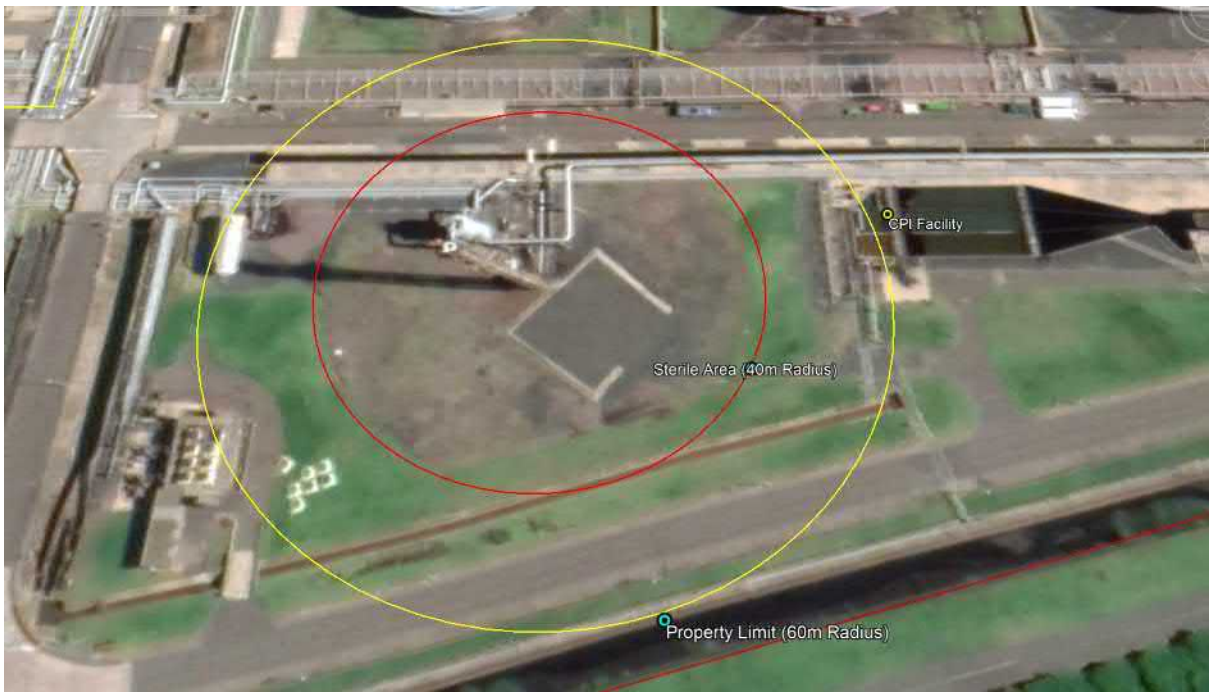


Figure 7: Delineation of Radiation Sterile Area and Property Limits

In order to achieve the radiation limits at the sterile area radius and the property limit with the full design flare gas flow height of the preferred option is to increase the height of the proposed flare to at least 77 m (17.7 m higher than the existing flare height of 59.3m).

2.4.3 PROPOSED FLARE TIP

The current and proposed flare tip includes a gas seal that consists of baffles that prevents reverse (inward) flow at the flare tip.

The current flare tip includes an external sparger for the injection of steam for cooling and to reduce smoke emissions. The proposed flare tip will instead have an internal sparger which introduces steam into the combustion zone resulting in better combustion resulting in improved smokeless flaring.

The steam flow through the sparger will be marginally increased and the control logic for steam flow will be optimised for performance.

The current flare tip includes pilots which are ignited by a flame front generator (FFG). The FFG operates by filling a combustion chamber and the lines connected it to the pilots with flammable mixture of methane rich gas (MRG) / hereafter referred to as fuel gas) and instrument air. This is ignited by means a spark inside the combustion chamber initiated at the discretion of an operator. This creates a flame front that travels to the pilots where it ignites the fuel gas venting into the atmosphere.

The proposed flare tip includes an automated High Energy Ignition (HEI) ignition system which will be easier to operate than the existing FFG system and will enable the flare to be operated more efficiently. A secondary FFG ignition system will be installed as a safety measure in the event of the failure of the primary ignition system – this is an additional safety measure to ensure that the flare is operational at all times when the refinery is operational.

The current flare tip includes refractory which is a heat resistant liner material used in the flare to prevent heat and chemical damage to the structure. Refractories are susceptible to various forms of mechanical damage (cracking, spalling and erosion) which can be blasted off during an upset potentially causing damage to equipment or vehicles; therefore, the proposed flare tip will be designed without refractory which is according to the latest international flare tip design standard and also eliminates any risks of damage to equipment/vehicles.

2.4.4 UTILITIES REQUIREMENTS

ELECTRICITY

The current and proposed flares both have a relatively low electricity requirement for lighting and for generating sparks in the pilot ignition system. The electricity demand associated with the project is within the available capacity of the refinery.

FUEL GAS

Fuel gas to the pilot burners will continue to be supplied at 1 barg from the existing local pressure regulators. The fuel gas requirement of the current and proposed flares will increase slightly.

STEAM

The replacement flare will increase the steam requirement in order to ensure optimal cooling and smoke reduction. Steam supply will be increased from c. 9.4 t/h. to c. 20t/h and will be generated within the existing steam generation capacity of the refinery.

WATER

The current total water demand of the refinery is 8801t/day comprising reclaimed water (from the eThekwini Southern Works water reclamation facility) and potable water from the municipal supply. The only water requirement for the flare is linked to steam supply. Based on the steam additional requirement the increase to current water consumption will be c. 0.02% which is considered marginal and not a significant water resource efficiency issue.

EFFLUENT / WASTEWATER

No effluent is generated by the current or proposed flares.

2.5 CONSTRUCTION ACTIVITIES

The construction process will follow industry standard methods and techniques. Key activities associated with the construction process are described in **Table 5**.

Table 5: Construction Activities

ACTIVITY	DESCRIPTION
Contractor's facilities and materials lay-down areas	These will be strictly located within laydown areas inside the existing refinery premises. Activities within these areas are likely to include: — Temporary offices and administration facilities (e.g. containers, portable cabins). — General materials storage and laydown areas. — Construction of chemicals storage facilities (oil, grease, solvents etc.) and associated infrastructure (bunds, secured / roofed areas etc.). — Change-houses, chemical toilets and showering facilities (linked to conservancy tanks – removal of contents by exhauster vehicle and disposal at permitted facility). — Temporary waste storage areas; these shall be established and managed in accordance with Environmental management Programme (EMPr) requirements.
Sourcing of construction materials and equipment	— Where possible, equipment will be sourced locally based on the latest information on South African Rand / US Dollar exchange rate. Equipment will be purchased outside of South Africa where this makes commercial sense.

Pre-construction Survey	— Locations for new flare base and guy wire anchor points (deadmen) will be surveyed prior to construction to identify existing aboveground services. — Slight changes in the location of infrastructure (micro-siting) may be required however this will not materially change the environmental impact of the project.
Piling and Foundations	— Removal of existing surfacing material (concrete, asphalt etc.) which could involve excavation below ground level. — Levelling and compaction using heavy machinery / earthmoving equipment – it is noted that the topography within the refinery is flat, therefore no major cut/fill or earth spoiling will be required. — Potential for excavations and trenching in order to prepare foundations and laying of below ground level equipment (cables, pipes, etc.). — Use of a piling rig to drive piles into soil to provide foundation support at the flare base as well as the anchor points (deadmen) for the guy wires. — Concrete materials (aggregate, cement, steel etc.) will be sourced from existing lawful commercial sources; there will be no direct mining, harvesting or extraction of natural resources.
Flare Installation	— Scaffolds will be erected to accommodate installation of new structures, supports, piping and painting. — The flare will be fully-assembled on the ground and then lifted into position with a crane with the assistance of rigging teams. — Piping run-ups (all above ground) to the flare will fabricated on site and installed.
Decommissioning of equipment	— Removal of the flare structure and associated piping, instrumentation, and electrical equipment. — Specific methods of demolition are still to be defined by the contractor; typically this will involve manual dismantling and the use of trucks and cranes, generators, cutting and welding equipment, compressors etc.
Working Hours	— Due to the heavy industrial nature of the refinery, it is not envisaged that daytime working hours would need to be adhered to; the exception would be in the case of excessively noisy activities which would be limited to normal daytime working hours if practical.

CONSTRUCTION PROGRAMME

The anticipated construction programme is provided in **Table 6**. The actual programme will be dependent on the timeframes for receiving Environmental Authorisation.

Table 6: Construction Programme

ACTIVITY	COMMENCEMENT DATE
Piling Work	April 2021
Civil Work	May 2021
Flare Stack Assembly	May 2021
Structural Steel Assembly	June 2021
Piping Fabrication	June 2021
Piping Installation	July 2021
Electrical and Instrumentation installation	August 2021
Commissioning	May 2022 ** The commissioning date is not moveable as it is linked to SAPREF's 2022 refinery turnaround project.

3 ALTERNATIVES

In terms of the Environmental Impact Assessment (EIA) Regulations, feasible alternatives should be considered within the BA process. Alternatives should be identified as early as possible in the project cycle and the search for alternatives should be well documented and should take into account the views of stakeholders.

Key criteria for consideration when identifying alternatives are that they should be "practicable", "feasible", "relevant", "reasonable" and "viable". In other words, while a range of alternatives might exist, not all will be necessarily appropriate for the project under consideration. The different categories of alternatives that were considered relevant for the current project include:

1) Site Alternatives – Alternative locations for the flare within the Refinery;
2) Technology Alternatives – Alternatives to an increase in the height of the replacement flare;
3) No-project Alternative – Continued use of the existing North Flare.

3.1 ALTERNATIVES CONSIDERED

3.1.1 SITE ALTERNATIVES

The proposed flare is proposed to be located at the same general location as the existing flare based on the presence of the knockout drum and seal drum (components of the current flare that will be retained) and the existing fuel, vent gas, and steam supply pipe connections.

Due to the density of infrastructure at the refinery, only one potential alternative site was identified in the early design stages (**Figure 8**). However, there was no reasonable technical justification for the alternative location based on the reasons already stated above.

In terms of environmental considerations, the alternative location would offer no advantages. There is no difference between the biological / ecological sensitivity of either of the alternative locations (both located within environmentally transformed areas of the refinery). The new location would will be approx. 100m closer to the Merebank community, which may marginally change the aesthetics of the refinery from an off-site vantage point.

For these technical and environmental reasons the alternate location is not considered reasonable and has been discarded.

Figure 8: Alternative North Flare Option

3.1.2 TECHNOLOGY ALTERNATIVES (ALTERNATIVE TO INCREASING STACK HEIGHT)

As already discussed in **Section 2.4.2**, to achieve the radiation limits at the sterile area radius and the property limit with the full design flare gas flow height of the new flare must be increased to at least 77 m (17.7 m higher than the existing flare height of 59.3m).

In terms of environmental considerations, it is recognised that the change in flare stack height could marginally change the aesthetics of the refinery from an off-site vantage point. Various alternative options were therefore considered as summarised in **Table 7**.

Table 7: Alternative Options for Achieving Heat Radiation Limits

OPTION	DESCRIPTION	EVALUATION
Access Control	Existing procedures would be reviewed, revised and enforced in accordance with the radiation limits. Additional access control would be required outside of the property limit.	By not raising the flare height, the sterile radius around the facility will become larger. This will create a scenario where the road outside the refinery is within the sterile radius which will require this area to be a public exclusion zone. In practice, the road will no longer be useable and no traffic will able to pass around the refinery. **This option was discarded accordingly.**
Shelters, Screens and Shields	Shelters, screens and shields are physical barriers that allow radiation limits to be met by blocking heat radiation.	This will require significant capital to shield all piping, tanks, vessels, and other process equipment around the flare. If the stack height is not increased the CPI system (currently located just outside of the sterile radius) will be within the radiation zone which is a major process safety risk. **This option was discarded accordingly.**

Load Reduction	The proposed flare capacity is based on Shell's requirements for depressurising units in a given amount of time. This option would involve a deviation from the standard by allowing a slight increase in the time allowed for depressurising which would reduce the radiation emitted from the flare.	The maximum safe depressurisation time that the flare must achieve is 20 minutes as per Shell specifications. Currently 15 minutes the basis. Although SAPREF could theoretically increase the depressurisation time to 20 minutes this will still require an increase to the flare stack height (albeit a smaller increase to circa. 70m). Increasing the depressurisation time to 20 minutes would also be regarded as a safety regression in terms of Shell standards which require the depressurisation to be achieved as quickly as possible (even though the case for a 20 minute depressurising time is allowed on paper, Shell's best practice is to depressurise units using the 15 minute minimum). **This option was discarded accordingly.**
Diversion to South Zone	In this option the entire relief would be sent to the South Flare. The studies indicated that this option would not be optimal due to the small diameter and flow constraints of the interconnecting pipework between the flares. In order for this option to be selected the capacity of the lines would need to be increased.	In order to divert the relief to the South Flare the relief gas pipe size would need to increase from is 10 inches (diameter) to 30 inches (diameter). The pipe would also need to be run for a significant distance (>1km) to the south zone. This would result in significant project cost and complexity as well as additional process risks. In addition, the South Flare would not be able to handle the worst-case (albeit very low probability) relief scenario (a fire at North Zone and a process upset at South Zone). **This option was discarded accordingly.**

3.1.3 NO-PROJECT ALTERNATIVE

The no-project alternative must be evaluated in terms of the EIA Regulations. In this option SAPREF will continue using the existing North Flare. This is not feasible as it will prevent prolonged safe and reliable operation of the refinery beyond 2022. The no-project option will also require SAPREF to rely on the balancing of the North Flare and the South Flare which results in complexity in ensuring the continuity of flaring capacity as a safety feature at the refinery.

The no-project option would prevent SAPREF from improving the environmental performance of the existing North Flare due to the inclusion of up-to-date technology, which will result in lower noise emissions and the improved combustion of potentially harmful gasses.

For the reasons provided above, the no project option is not considered reasonable or feasible and has not been evaluated further in this BA Report.

3.2 JUSTIFICATION OF THE PREFERRED ALTERNATIVE

Based on the evaluation of alternatives, the replacement of the North Flare at the existing location; and the increase of the flare height to ensure worker/public safety, is the preferred option.

4 DESCRIPTION OF ENVIRONMENTAL ATTRIBUTES

This section includes a description of the environmental attributes of the project area. The descriptions encompass the geographical, physical, biological, social, economic, heritage and cultural aspects in accordance with EIA Regulations GN. R.326 (Appendix 1).

4.1 METEOROLOGY

Seasonal and diurnal pollutant concentration levels fluctuate in response to the changing state of atmospheric stability, to concurrent variations in mixing depth and to the influence of mesoscale and macroscale wind systems on the transport of atmospheric contaminants. This section provides an overview of the atmospheric circulations influencing airflow and the subsequent dispersion and dilution of pollutant concentrations in the south Durban Basin.

Localised airflow in South Durban is described as a system of drainage winds that flow down the Umbilo and the Umhlatuzana valleys at night, across the alluvial flats at the head of the bay and up against the Bluff ridge (Figure 9)[3]. From here, the air is diverted between the Bluff and Berea ridges as gentle south-westerly winds towards Durban's central business district. The accumulation of cold air in the Durban South basin may lead to valley inversions at night, limiting vertical dispersion. This local wind pattern is regularly disrupted by the passage of coastal lows and westerly wave frontal systems that clear the boundary layer every three to five days during the winter months.

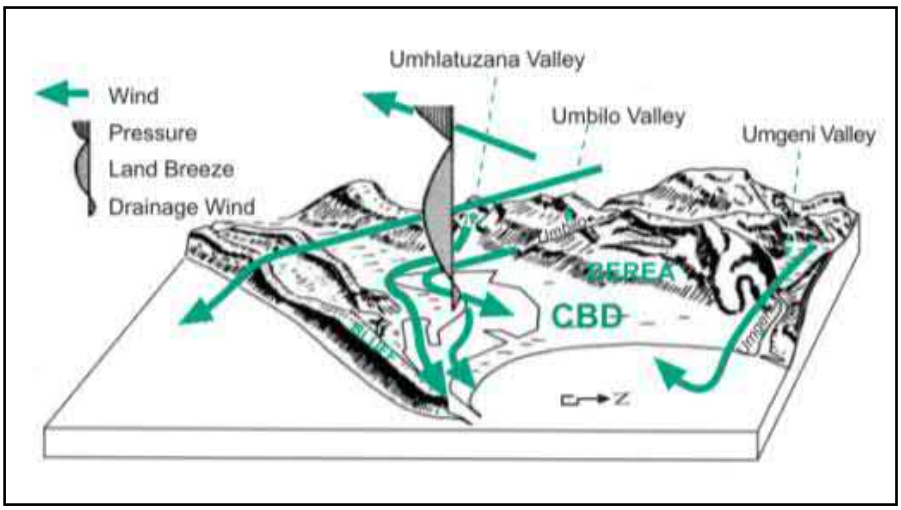


Figure 9: Nocturnal air circulations in Durban (Preston-Whyte and Diab, 1980)

Meteorological variables, including hourly temperature, rainfall, humidity, atmospheric pressure, wind speed and wind direction, were obtained from the nearest station operated by SAWS and analysed for the period January 2017 - December 2019 (i.e. three calendar years as required by the *Modelling Regulations*). Data was sourced from the Merebank station (approximately 2 km to the north-northeast of SAPREF) which was moved to Athlone Park (approximately 5 km to the southwest of SAPREF) in May 2018. Station details and data recovery

[3] Preston-Whyte and Diab, R.D. (1980): Local Weather and Air Pollution: The Case of Durban, Environmental Conservation, 7, 241- 244.

information is given in **Table 8.** Although not specific to site, both stations are located in a similar geophysical context as SAPREF (**Figure 10**), and thus considered representative of meteorological conditions at site.

Table 8: Details of meteorological stations and dataset recovery

Station Name	Latitude (°S)	Longitude (°E)	Altitude (m)	Data recovery				
				Temp	Rain	Wind	Humidity	Pressure
Merebank	-29.9560	30.9560	8	100%	97%	99%	97%	100%
Athlone Park	-30.0130	30.9260	96					

Figure 10: Location of Athlone Park meteorological station

4.1.1 TEMPERATURE, RAINFALL AND HUMIDITY

Ambient air temperature influences plume buoyancy as the higher the plume temperature is above the ambient air temperature, the higher the plume will rise. Further, the rate of change of atmospheric temperature with height influences vertical stability (i.e. mixing or inversion layers). Rainfall is an effective removal mechanism of atmospheric pollutants.

Figure 11 illustrates the average monthly temperature, rainfall and humidity as recorded for Durban South. Higher rainfall occurs during the warmer, summer months (December, January and February) with drier conditions during the cooler, winter months (June, July and August). Summer temperatures for the region average at 23.4°C while winter temperatures average at 18.1°C. South Durban received on average 900 mm of rainfall each year, with approximately 35% of that received during the summer months and 5% during the drier winter months.

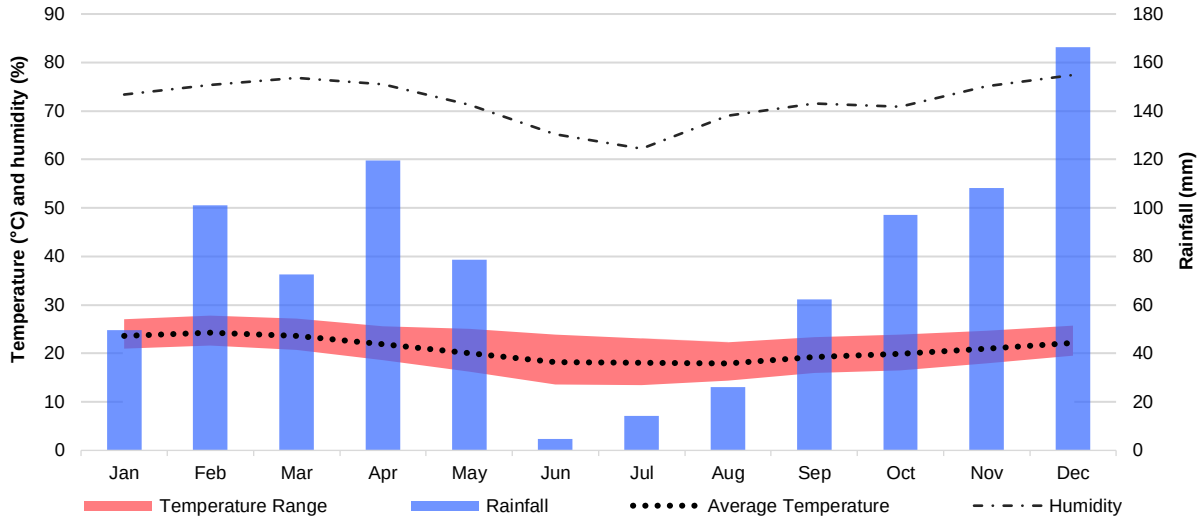


Figure 11: Meteorological summary for Durban South, January 2017 – December 2019

4.1.2 WIND FIELD

Wind roses (Figure 12) summarize wind speed and directional frequency at a location. Each directional branch on a wind rose represents wind originating from that direction. Each directional branch is divided into segments of colour, representative of different wind speeds. Calm conditions are defined as wind speeds less than 1.0 m/s (i.e. based on the typical sensitivity of the wind sensor installed at SAWS stations).

Typical wind fields have been analysed using Lakes Environmental WRPlot Freeware (Version 7.0.0) for the full period (January 2017 – December 2019); diurnally for early morning (00h00 – 06h00), morning (06h00 – 12h00), afternoon (12h00 – 18h00) and night (18h00 – 00h00); and seasonally for summer (December, January and February), autumn (March, April and May), winter (June, July and August) and spring (September, October and November):

- Calm conditions (wind speeds <1.0 m/s) occurred 8.68% of the time;
- Light to fresh winds from the north-northeast and light to strong winds from the south-southeast prevail along Durban's coastline;
- Peak wind speeds occurred from the west (14.9 m/s) and highest average wind speeds occurred from the south and south-southwest (5.2 m/s);
- Southerly, south-southwesterly and north-northeasterly winds prevailed in the morning (06h00-12h00);
- Winds from the south and northeast prevailed in the afternoon (12h00-18h00);
- North-northeasterly and southwesterly winds prevailed during the night (18h00-00h00);
- Southwesterly to westerly and northerly winds prevailed during the early morning hours (00h00-06h00);
- Diurnal peak (13.2 m/s) and highest average (4.3 m/s) wind speeds occurred during the afternoon;
- Prevailing north-northeasterly and southerly to southwesterly winds are noted throughout the year with slight variability in seasonal frequency and strength;
- Higher directional variability in the wind field is observed during winter when the frequency of calm conditions increase and westerly drainage winds are more prominent; and
- Seasonal peak (13.5 m/s) and highest average (3.8 m/s) wind speeds occur during spring.

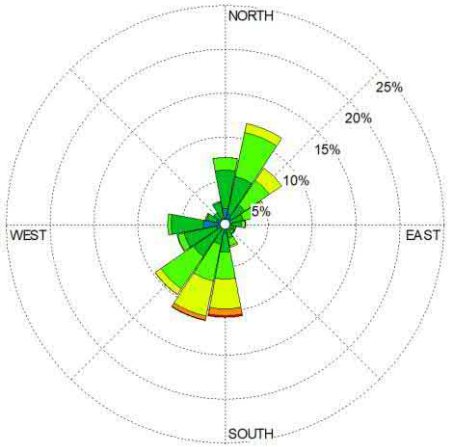
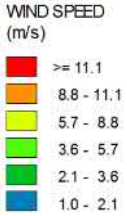
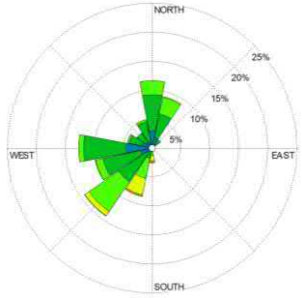
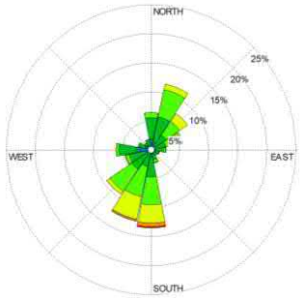
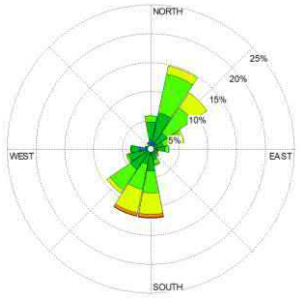
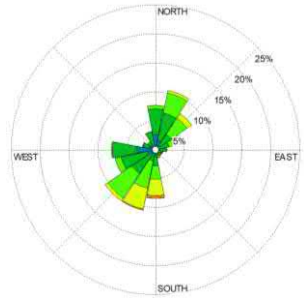
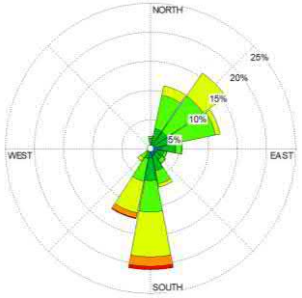
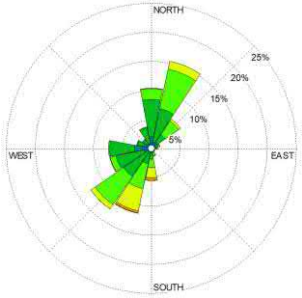
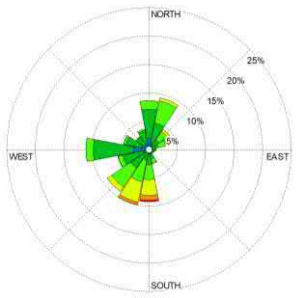
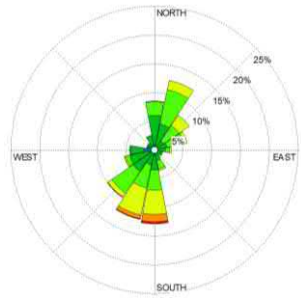
South Durban	Early Morning	Morning	Summer	Autumn
January 2017 – December 2019	00h00 – 06h00	06h00 – 12h00	December, January & February	March, April & May
 Calms = 8.68% 	 Calms = 12.96%	 Calms = 7.30%	 Calms = 6.62%	 Calms = 9.5%
Afternoon	**Night**	**Winter**	**Spring**	
12h00 – 18h00	18h00 – 00h00	June, July & August	September, October & November	
 Calms = 2.60%	 Calms = 7.89%	 Calms = 10.35%	 Calms = 4.45%	

Figure 12: Local wind conditions at South Durban

4.2 AIR QUALITY

Ambient air quality monitoring data has been sourced from three monitoring stations in the region, namely Wentworth, Ganges and Settlers. All stations are owned and managed by the eThekwini Metropolitan Municipality. Data for the period January 2017 – December 2019 was assessed for compliance with applicable NAAQS. A minimum data recovery of 90% is required for assessing compliance with national standards[4]. With the exception of the Wentworth station (i.e. PM_{10} measured during 2019), data recovery across the pollutant array measured by all stations failed to meet this requirement. Nonetheless, in the absence of any other site relevant monitoring data, the available information has been used to provide insight into background pollutant concentrations in the study area. The results presented in the sections below must be considered in the context of low data recovery. Where hourly concentrations were provided in parts per billion (ppb), these were converted to micrograms per cubic metre ($\mu g/m^3$) using temperature and pressure for the corresponding date and hour as measured by the SAWS meteorological station (**Section 4.1**). Station information and data recovery is presented in **Table 9** and **Figure 13**.

Table 9: Station information, data recovery and results summary for the period January 2017 – December 2019

Station name		Wentworth	Ganges	Settlers
Latitude (°S)		-29.934095	-29.948504	-29.958842
Longitude (°E)		30.988598	30.9646	30.978683
Direction from study site		NE	NNW	NNE
Distance from study site (km)		2.12	2.82	4.92
Data recovery	**2017**			
	PM_{10}	NM	29.4%	NM
	NO_2	0.6%	18.8%	NM
	SO_2	NM	NM	37.9%
	2018			
	PM_{10}	30.4%	8.9%	NM
	NO_2	NM	31.1%	NM
	SO_2	15.4%	18.5%	16.5%
	2019			
	PM_{10}	91.4%	74.3%	48.9%
	NO_2	NM	NM	NM
	SO_2	72.8%	68.6%	52.2%
Notes: NM – not measured				

[4] South African National Accreditation System (SANAS, 2012) in *TR 07-03*

Figure 13: Ambient air quality monitoring stations

4.2.1 PARTICULATE MATTER LESS THAN 10 MICROMETRES IN DIAMETER

Average PM_{10} concentrations and the number of recorded NAAQS exceedances measured per year are provided in Table 10Error! Reference source not found..

Table 10: Measured ambient PM_{10} for 2017, 2018 and 2019

PM_{10} (µg/m^3)	Period	Wentworth	Ganges	Settlers
24-hour NAAQS exceedances	2017	NM	0	NM
	2018	0	0	NM
	2019	35	78	36
Peak 24-hour concentration	2017 - 2019	172.12	287.70	179.87
Annual average concentration	2017	NM	16.69	NM
	2018	29.76	10.52	NM
	2019	39.87	69.67	53.08

Notes:
NM – not measured
Red – exceeds NAAQS limits

PM_{10} concentrations measured at Wentworth (**Figure 14**Error! Reference source not found.) for 2018 and 2019 averaged below the annual NAAQS (40 µg/m^3) at 29.79 µg/m^3 and 39.87 µg/m^3 respectively. Ambient

concentrations exceeded the 24-hour NAAQS (75 µg/m^3, four exceedances permitted) 35 times in 2019. PM_{10} was not measured at Wentworth during 2017.

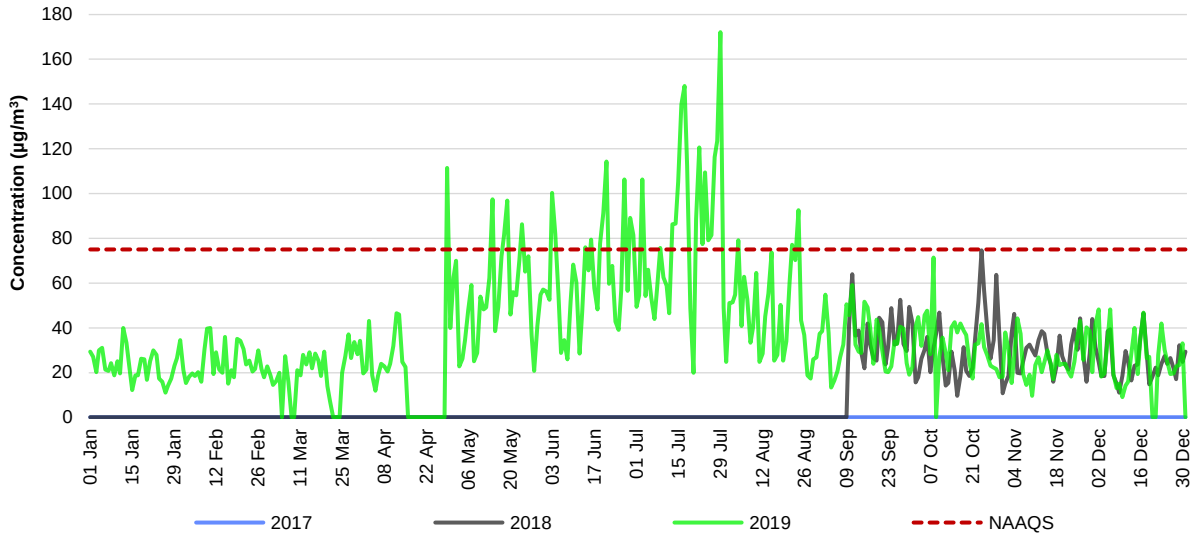


Figure 14: 24-hour PM_{10} concentrations measured at Wentworth

PM_{10} concentrations measured at Ganges (**Figure 15**Error! Reference source not found.) for 2017 and 2018 averaged below the annual NAAQS (40 µg/m^3) at 16.69 µg/m^3 and 10.52 µg/m^3 respectively. PM_{10} concentrations measured for 2019 exceeded the annual NAAQS (40 µg/m^3) at 69.67 µg/m^3. No exceedances of the 24-hour NAAQS (75 µg/m^3, four exceedances permitted) were measured in 2017 and 2018. PM_{10} concentrations exceeded the 24-hour NAAQS (75 µg/m^3, four exceedances permitted) 78 times in 2019.

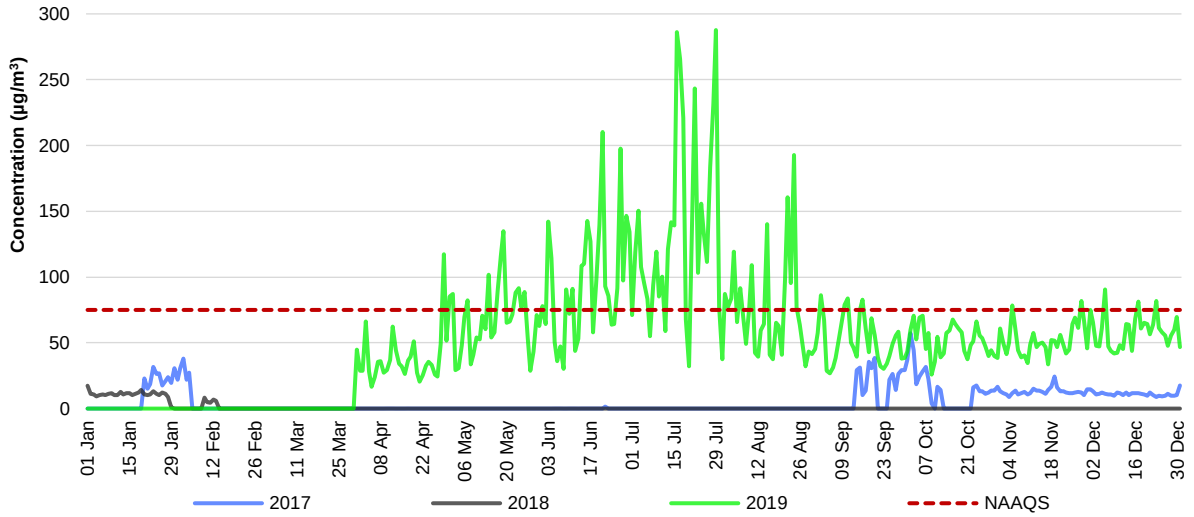


Figure 15: 24-hour PM_{10} concentrations measured at Ganges

PM_{10} concentrations measured at Settlers (**Figure 16**) for 2019 exceeded the annual NAAQS (40 µg/m^3) at 53.08 µg/m^3. PM_{10} concentrations exceeded the 24-hour NAAQS (75 µg/m^3, four exceedances permitted) 36 times in 2019. PM_{10} was not measured at Settlers during 2017 and 2018.

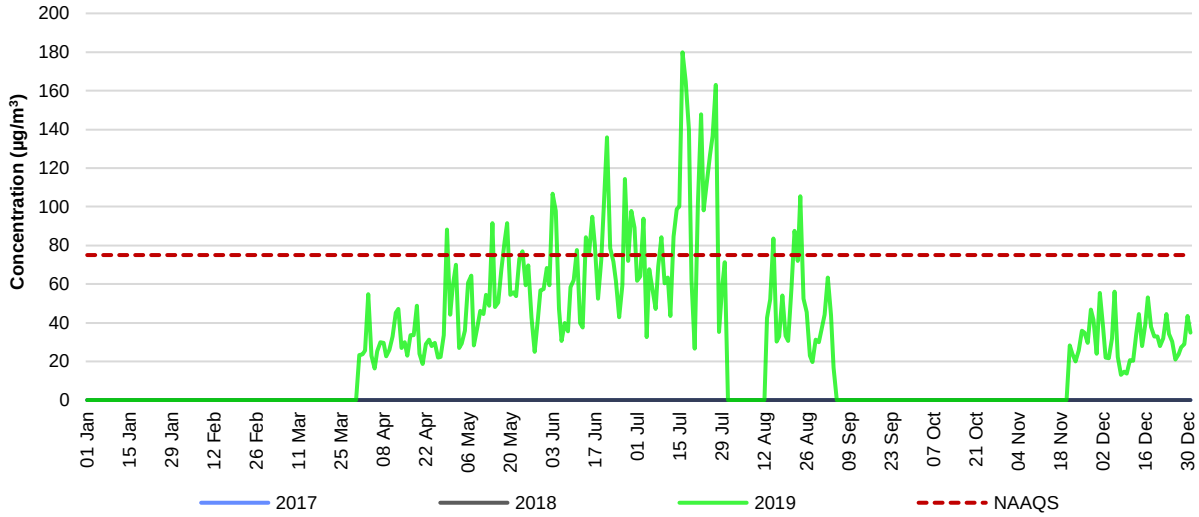


Figure 16: 24-hour PM_{10} concentrations measured at Settlers

4.2.2 NITROGEN DIOXIDE

Average NO_2 concentrations and the number of recorded NAAQS exceedances measured per year are provided in **Table 11**.

Table 11: Measured ambient NO_2 for 2017, 2018 and 2019

PM_{10} (µg/m³)	Period	Wentworth	Ganges	Settlers
1-hour NAAQS exceedances	2017	0	554	NM
	2018	NM	511	NM
	2019	NM	NM	NM
Peak 1-hour concentration	2017 - 2018	8.21	746.08	NM
Annual average concentration	2017	1.53	165.03	NM
	2018	NM	113.06	NM
	2019	NM	NM	NM

Notes:
NM – not measured
Red – exceeds NAAQS limits

The NO_2 dataset for the Wentworth station is too limited (0.6% data recovery for 2017 and not measured in 2018 and 2019) to provide meaningful input to this study and therefore has not been analysed further. NO_2 is not measured at the Settlers station.

NO_2 concentrations measured at Ganges (**Figure 17**Error! Reference source not found.) for 2017 and 2018 exceeded the annual NAAQS (40 µg/m³) at 165.03 µg/m³ and 113.06 µg/m³ respectively. NO_2 concentrations exceeded the 1-hour NAAQS (200 µg/m³, 88 exceedances permitted) 554 and 511 times in 2017 and 2018 respectively. NO_2 was not measured at Ganges during 2019.

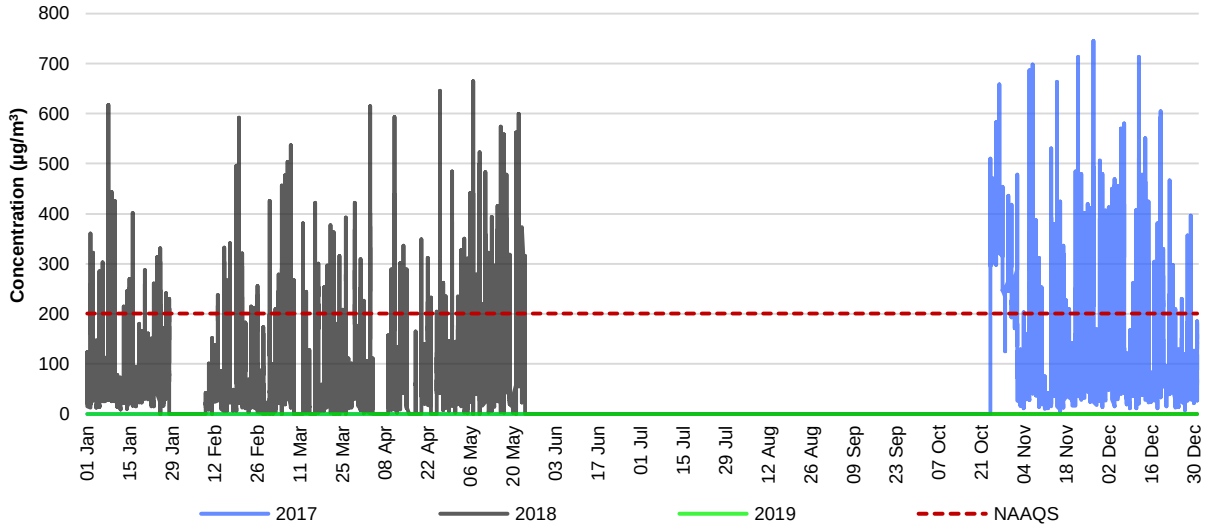


Figure 17: 1-hour NO_2 concentrations measured at Ganges

4.2.3 SULPHUR DIOXIDE

Average SO_2 concentrations and the number of recorded NAAQS exceedances measured per year are provided in **Table 12**Error! Reference source not found..

Table 12: Measured ambient SO_2 for 2017, 2018 and 2019

PM_{10} (µg/m³)	Period	Wentworth	Ganges	Settlers
1-hour NAAQS exceedances	2017	NM	NM	3
	2018	0	0	0
	2019	3	0	1
Peak 1-hour concentration	2017 - 2019	1152.47	193.17	475.02
24-hour NAAQS exceedances	2017	NM	NM	0
	2018	0	0	1
	2019	1	0	0
Peak 24-hour concentration	2017 - 2019	172.12	47.02	143.29
Annual average concentration	2017	NM	NM	14.64
	2018	15.65	9.48	18.94
	2019	22.78	10.03	18.58
Notes: NM – not measured				

SO_2 concentrations measured at Wentworth for 2018 and 2019 averaged below the annual NAAQS (50 µg/m³) at 15.65 µg/m³ and 22.78 µg/m³ respectively. Ambient concentrations exceeded the 24-hour NAAQS (125 µg/m³, four exceedances permitted) one time in 2019 (**Figure 18**). Ambient concentrations exceeded the 1-hour NAAQS (350 µg/m³, 88 exceedances permitted) three times in 2019 (**Figure 19**Error! Reference source not found.). SO_2 was not measured at Wentworth during 2017.

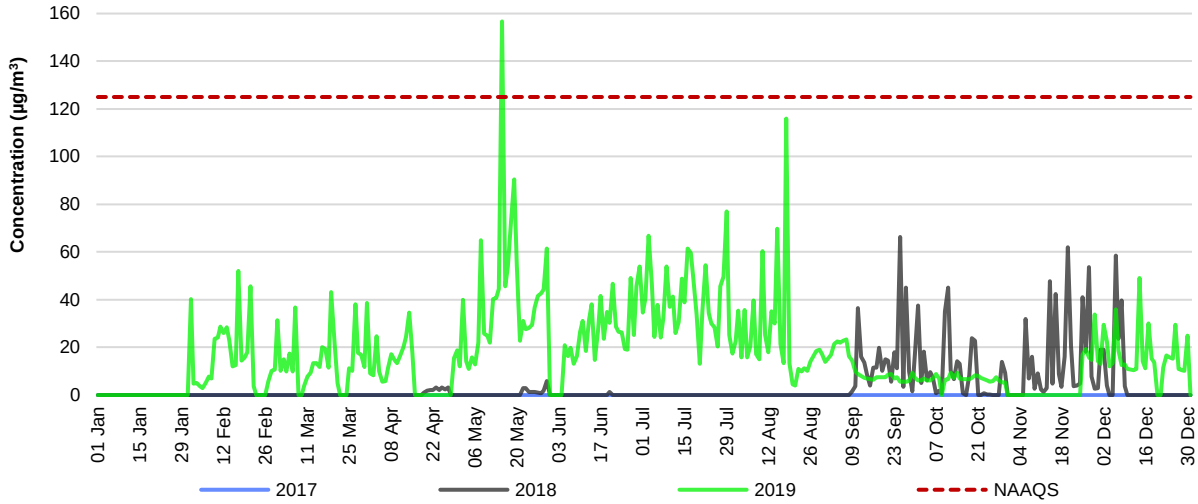


Figure 18: 24-hour SO_2 concentrations measured at Wentworth

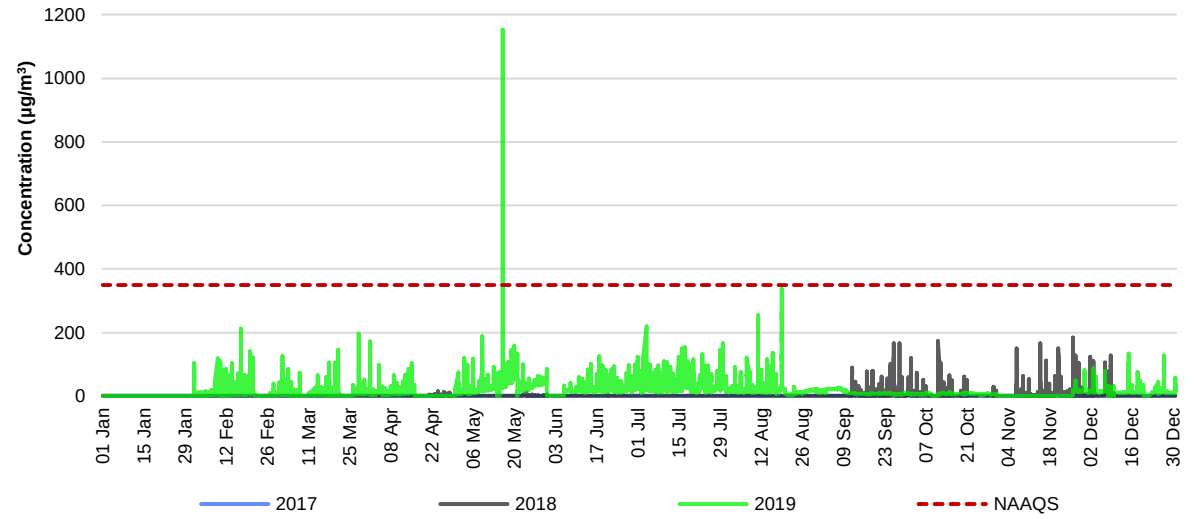


Figure 19: 1-hour SO_2 concentrations measured at Wentworth

SO_2 concentrations measured at Ganges for 2018 and 2019 averaged below the annual NAAQS (50 µg/m^3) at 9.48 µg/m^3 and 10.03 µg/m^3 respectively. No exceedances of the 24-hour NAAQS (125 µg/m^3, four exceedances permitted) (**Figure 20**Error! Reference source not found.) or the 1-hour NAAQS (350 µg/m^3, 88 exceedances permitted) (**Figure 21**) were measured. SO_2 was not measured at Ganges during 2017.

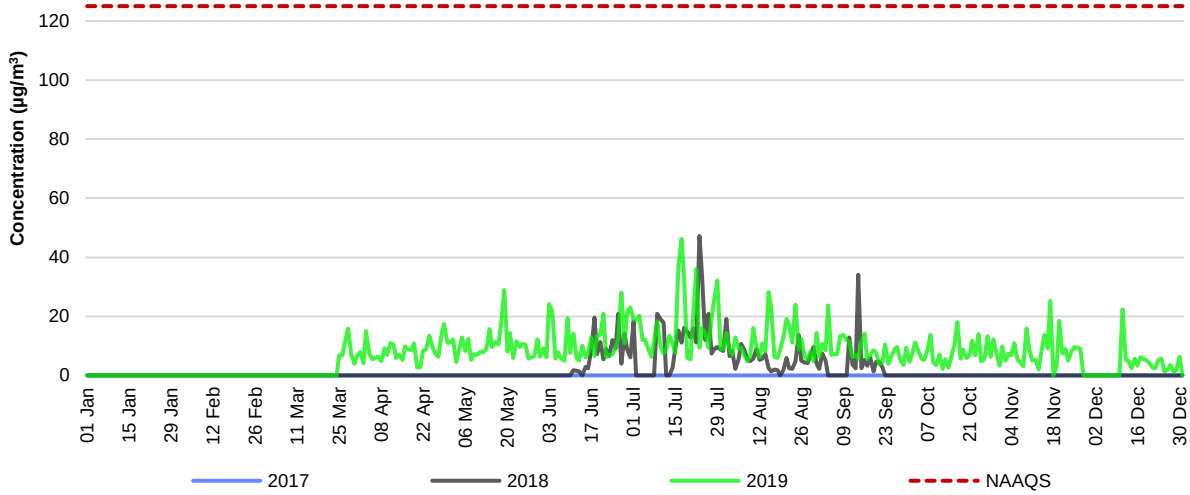


Figure 20: 24-hour SO_2 concentrations measured at Ganges

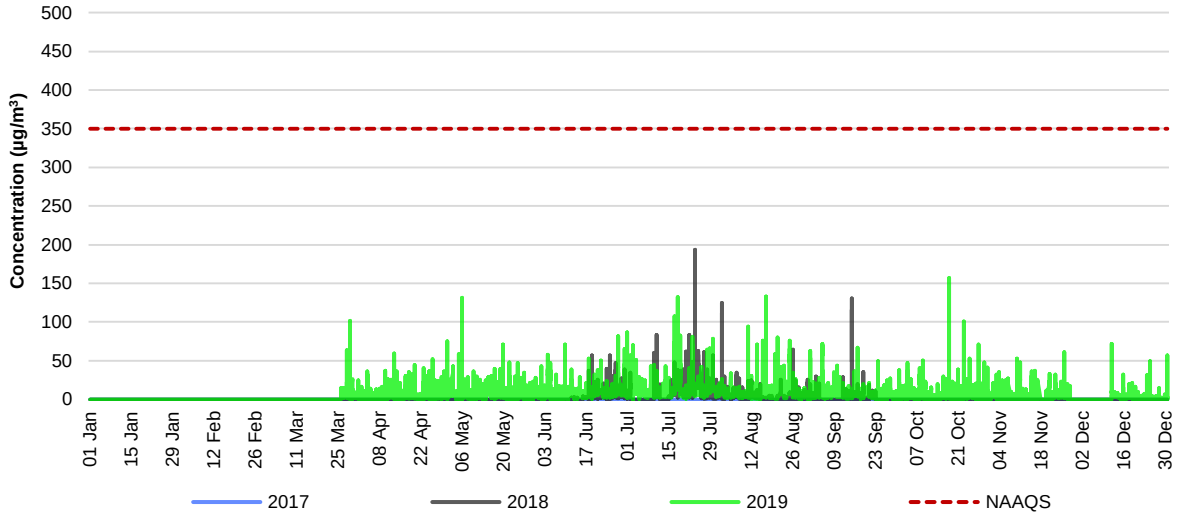


Figure 21: 1-hour SO_2 concentrations measured at Ganges

SO_2 concentrations measured at Settlers for 2017, 2018 and 2019 averaged below the annual NAAQS (50 µg/m^3) at 14.64 µg/m^3, 18.94 µg/m^3 and 18.58 µg/m^3 respectively. Ambient concentrations exceeded the 24-hour NAAQS (125 µg/m^3, four exceedances permitted) one time in 2018 (**Figure 22**). Ambient concentrations exceeded the 1-hour NAAQS (350 µg/m^3, 88 exceedances permitted) three times in 2017 and one time in 2019 (**Figure 23**).

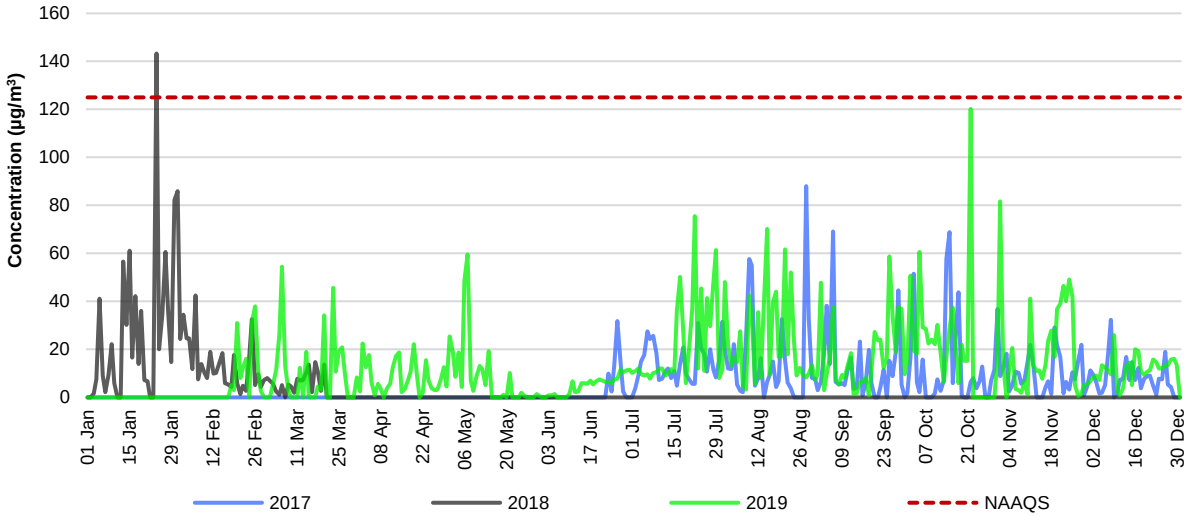


Figure 22: 24-hour SO_2 concentrations measured at Settlers

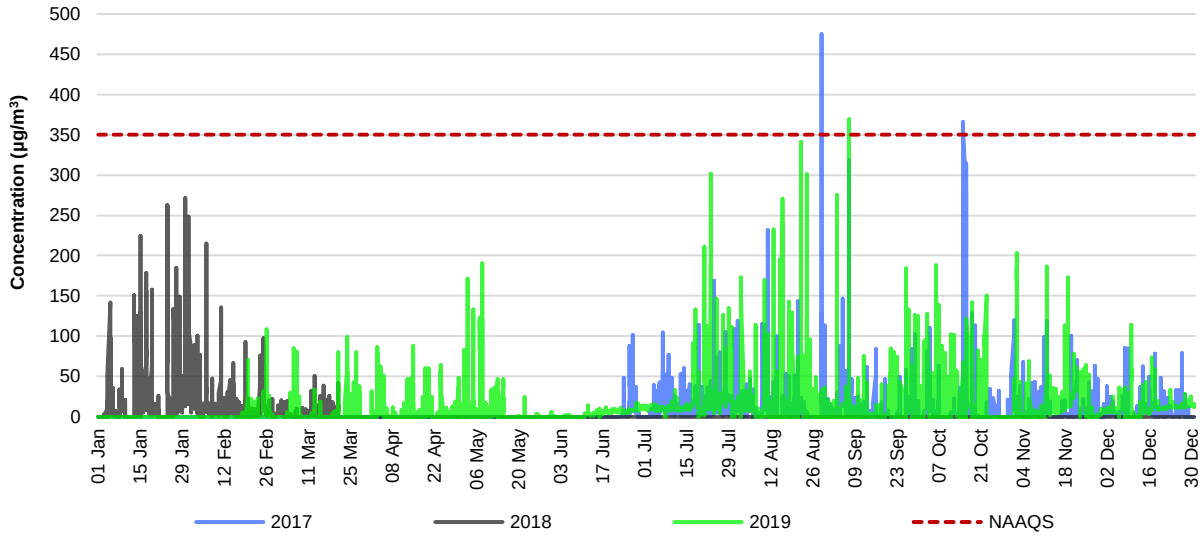


Figure 23: 1-hour SO_2 concentrations measured at Settlers

4.3 NOISE

Baseline noise levels in the south Durban basin are a function of a wide range of sources including industrial operations (heavy machinery and equipment, loading and unloading of materials, operational processes, etc.) and road traffic (heavy vehicular and commuter traffic).

Noise from air traffic was historically a significant source up until the relocation of the Durban International Airport to north of Durban. There is currently no systematic noise measurement program carried out in the area, from which an assessment of the environmental noise climate for the region can be performed. However, numerous complaints have been reported to eThekwini Municipality, clearly indicating that noise is a nuisance in the region.

The SAPREF site is situated between the old Durban International Airport and the coastline. The area between the airport and the site is covered with vegetation and the closest residential community to the North Flare location

is approximately 0, 8km north, and approximately 2.9km south. The current offsite noise sources are road traffic and various activities associated with industries located to the south west of the SAPREF Refinery.

PREVIOUS NOISE MONITORING (APEX, 2020)

A noise study was carried out in 2020 by Apex on behalf of SAPREF during shutdown and start up conditions, Measurements were recorded at various boundary locations at the Refinery. The results of the study are summarised below:

Table 13: Summary of Refinery Boundary Noise Levels (2020)

OPERATIONAL PHASE	DAY-NIGHT EQUIVALENT CONTINUOUS LEVEL (DB)			
	Highest	**Lowest**	**Average**	**Range**
Start-up Period	80.2	50.3	60.7	5.3
Shut-down period	68.6	54.4	65	13.6

1) The results are representative of the refinery boundary where no communities are resident. The nearest community is 308m to the north of the boundary.
2) Noise barriers in the form of vegetation, topographical elevation, structural elements etc. were anticipated to aid in the reduction of noise levels further afield.
3) Noise sources at the monitoring locations included contributions from other industries in the area.
4) The results were indicative of the conditions that prevailed during the test period. Operational and environmental factors may effect noise transmission causing variation in the noise readings.

4.4 GEOLOGY AND SOILS

The 1:250 000 Geological Map of Durban (Series 2930) indicates that the South Durban basin Area is underlain by recent alluvial soils and Quaternary sediments (Harbour Beds) flanked on both sides by aeolian sands of the Berea Formation. These sediments overlie Cretaceous bedrock of the St. Lucia Formation. The Cretaceous bedrock is, in turn, underlain by Sandstone of the Natal Formation and Tillite of the Dwyka Formation.

The local geological conditions below the Refinery Site are relatively variable, both with depth and lateral distribution. The bulk of the area is covered by fill material brought in during construction of the Airport, which comprises 1 to 2 meters of silty sands and clayey sands of the Berea Formation. The fill is underlain by the Harbour Beds, which are a thick sequence of estuarine and lagoonal sediments, comprising predominantly sand with subordinate layers and lenses of clay. These sediments extend to depths varying between 37 and 46m below existing ground level, and are underlain by Cretaceous bedrock. There is frequently a thin clay layer immediately underlying the fill. This clay layer is generally unconsolidated and very soft in consistency.

4.5 GEOHYDROLOGY

There are unconfined and semi-confined aquifer conditions beneath the site, due to the presence of a discontinuous shallow clay layer beneath portions of the Site, and the piezometric levels recorded in the piezometers installed at different depths reflect this condition (Moore Spence Jones, 2010).

The elevation of the unconfined groundwater aquifer beneath the site ranges between approximately 1 and 6m above mean sea level (mamsl). The projected groundwater flow patterns indicate groundwater flow in the area is predominantly to the east, with a hydraulic gradient of approximately 1 in 300 (Moore Spence Jones, 2010).

Groundwater levels on the site are relatively shallow, with levels ranging from 1.02 meters below ground level (mbgl) in the north east of the site, to 6.61 mbgl in the south west of the site. Local groundwater flow in the northern portion of the site is to the north east, towards the uMlazi Canal, and in the southern portion of the site is to the south east, towards the Reunion Canal.

4.6 TOPOGRAPHY AND HYDROLOGY

The site occurs in a relatively low-lying flat area that exists between the Bluff Coastal Dune to the east and Isipingo Hills to the west. This flat, former wetland area, previously incorporated the Durban Bay Harbour, and extended from the foreshore and Central Business District (CBD) area of Durban south to Isipingo and Prospecton. Historically, major rivers meandered across this area, flowing either into Durban Bay or into the sea at Isipingo.

Two rivers, namely the Isipingo and uMlazi River, are the main drainage features in the vicinity of the Refinery. The Isipingo River occurs to the south of the site. The mouths of both the Isipingo and uMlazi Rivers were often closed by a sand bar that caused flooding of the low-lying wetland area. The natural ground levels in the wetland area are generally less than 4.0 mamsl. However, much of the wetland area has over the years been reclaimed for the development of the Old Durban Airport, SAPREF, Pep Stores Warehouse (formerly Sasol Fibres) and Shell Chemicals. Imported fill was used to raise the developed areas to elevations of between approximately 4.0 and 7.0 mamsl. The Refinery site varies in elevation between approximately 3.0 and 6.0 mamsl, with an average elevation of approximately 4.0 mamsl over the Main Plant Area. The southern tank farm has been constructed on a platform with an average elevation of approximately 6.0 mamsl, while the adjacent wetland area to the south is at an elevation of approximately 3.0 mamsl (MSJ 2010).

The Reunion Canal crosses the southern portion of the Refinery. This drainage canal drains the Airport and surrounding area and Shell Chemicals to the west. It crosses SAPREF immediately north of the southern tank farm, where it joins the Swamp Canal that flows along the eastern boundary of SAPREF. These canals discharge into the sea approximately 450 metres downstream of their confluence.

Two rivers namely the Isipingo River to the South and Mlazi River to the north are the main drainage features in the vicinity of the Refinery. The Mlazi Canal, also known as the Umlazi and Umlaas Canal, is situated between Merewent and the old Durban International Airport (DIA). The Mlazi River once joined the Isipingo River in the Isipingo mangrove swamp area, and flowed into the sea via the Isipingo Estuary. However, the Mlazi River was diverted through an artificial concrete channel during the construction of the DIA in 1952. The airport was built on land that was originally a river floodplain / wetland and the Mlazi Canal functions in draining the remnants of the wetland into the Indian Ocean. The water flowing through the canal is of extremely poor quality with high phosphate loads and low oxygen levels. The Isipingo Estuary is regarded as “highly degraded” with poor water quality due to significant past modifications resulting in impoverished benthic invertebrate and fish communities (Forbes & Demetriades, 2008).

In the south Durban basin, the general movement of surface water is in a north-westerly direction downslope into the basin and toward the man-made canals where it enters the Indian Ocean. Surface water within the canals is classified for industrial use and is not suitable for direct human consumption.

4.7 ECOLOGY

TERRRESTRIAL ECOLOGY

The natural dune to the east of the Refinery (which forms part of SAPREF’s property) is characterised by indigenous dune forest and to a lesser extent, alien invasive species. This area is identified on the Environmental Atlas of KZN as being of special scientific interest and having key vegetative communities.

The majority of the central and northern refinery areas comprise hard standing, process areas and maintained lawn does not provide suitable habitat for the majority of flora, fauna, and avifauna (birds).

The vegetation areas of interest located in the northern portion of the refinery where the North Flare is located is ‘block 8’ as illustrated in **Figure 24**. Block 8 comprises the northern portion of the inland dune. The vegetation in this area is characterised coastal forest in good condition containing very low infestation of invasive alien plant species. The dominant indigenous species in this area were

- Honeysuckle-tree (*Turraea floribunda*)
- Flat-crown albizia (*Albizia adiantifolius*)
- Dune false-currany (*Allophylus natalensis*)
- White Stinkwood (*Celtis Africana*)
- African dog rose (*Acacia kraussiana*)
- Natal ebony (*Euclea natalensis*)
- Narrow-leaf Caper-bush (*Capparis brassii*)
- Zulu cherry-orange (*Teclea gerardii*)
- Common sourberry (*Dovyalis rhamnoides*)
- Small knobwood (*Zanthoxylum capense*)
- *Drypetes argute*
- Hairy Star-apple (*Diospyros villosa*)

Figure 24: Vegetation Management Blocks (Source: Sabeliwe Environmental Services)

AQUATIC ECOLOGY (WETLANDS AND RIPERIAN ZONES)

A wetland report conducted in 2019 (WSP, 41101140) identified a total of eight wetland systems within a 500m radius of the Refinery (**Figure 25**). The identified systems appear to have formed part of a historical flood plain wetland that had been modified over time in order to make way for the development within the area. As a result, the system has been infilled in portions and segmented into smaller systems with changes to the historical floodplain.

Wetlands occurring on the northern portion are identified / within the potential area of influence of the project are W1 and W2 occurring c. 850m and c. 750m northwest of the North Flare respectively. Both of these wetlands are located up gradient of the Refinery site, as such they are hydrologically isolated from the refinery (i.e. any surface water flows from the refinery are not anticipated to enter to the wetland system). For this reason detailed studies on these wetland systems were not justified.

Figure 25: Wetlands within 500m of SAPREF Boundary

4.8 SOCIO-ECONOMIC ENVIRONMENT

REGIONAL CONTEXT

eThekwini Municipality spans an area of approximately 2 297km² and is home to some 3.8 million people in 2016. The eThekwini Municipality consists of a diverse society, which faces a variety of social, economic, environmental and governance challenges. eThekwini is characterised as having a growing economy, and is the primary economic contributor (65.5%) to KZN's Gross Domestic Product (GDP). The eThekwini economy grew by 0.9% in 2016. eThekwini's economy is dominated by tertiary industries including contributions from the finance (20%), manufacturing (19%), community services (20%), trade (18%) transport (14%) and construction (5%) sectors. The production of fuel and petroleum are significant contributors to the manufacturing sector in the municipality (eThekwini, May 2012).

According to Statistics South Africa (2012), the unemployment rate within eThekwini Municipality was 30.2%, with 17.1% households having no income.

The tertiary sector accounts for the largest portion of the workforce which includes community services, finance and trade, followed by manufacturing. In terms of skill levels, the largest portion of the workforce is employed at semi-skilled level followed by skilled and low skilled.

The eThekwini Municipality has improved infrastructure delivery, with 86% having access to electricity for cooking and 89.9% for lighting.

LOCAL CONTEXT

The refinery falls within with Ward 90 of the eThekwini Municipality and comprises 1) Community areas: Isipingo Beach, Isipingo Hills, Isipingo Rail, Malaba Hills, Orient Hills, and Lotus Park; and, 2) Industrial areas: Prospecton Industrial Area, and former Durban International Airport site.

The communities within close proximity (within 2km radius) to the SAPREF Refinery include Isipingo Beach to the south, and Merewent / Merebank to the north / north east. The neighbouring ward to the north is Ward 68 which consists of the communities of Merewent, Merebank, and Austerville, as well as industrial activities such as the Mondi Merebank paper manufacturing facility and Southern Waste Water Treatment Works (SWWTW).

DEMOGRAPHY AND EDUCATION

According to the Census 2011 data, Ward 90 is characterised by a predominately Indian (53%) and African (44%) population. Ward 68 is characterised by a predominately Coloured (53%), Indian (33%) and African (13%) population (Census, 2011). Education levels in Ward 90 and 68 are comparable with 3% of the population having no schooling and 41% to 43% with high school qualifications.

EMPLOYMENT AND INCOME

In 2011, of the population aged 16 to 65 years across Ward 68 and Ward 90, 38,4% and 45,4% were employed and 59,4% and 50,5% were unemployed. An analysis of personal income across Ward 68 and Ward 90 demonstrates that the number of people with no income is 47.41% and 57.46% respectively.

4.9 HERITAGE AND CULTURAL ASPECTS

Building work on the SAPREF refinery (located on reclaimed low lying wetland area) started in 1960 and it has subsequently been in operation for more than 50 years. The site is occupied by crude oil tanks, intermediate and product storage tanks, process plants, dispatch areas, effluent holding ponds, administration offices, and numerous auxiliary structures. The process areas of the site are largely paved in concrete or asphalt. The Refinery has been fully transformed from its natural state and due to its brownfield nature is unlikely to contain significant cultural heritage resources other than buildings older than 60 years.

The North Flare project does not involve the demolition of such dated structures. Exemption from having to undertake a Heritage Impact Assessment (for construction of pipelines exceeding 300m in length within the existing Refinery boundary) was granted by Amafa on previous EIA studies at SAPREF (Cleaner Fuels, 2013) on the basis that potential heritage value of the site is not significant. A similar motivation for exemption will be sought for the North Flare project.

4.10 TRAFFIC AND SITE ACCESS

Traffic volumes in the areas surrounding the SAPREF Refinery are highly variable, however the road infrastructure is well-developed and the primary transportation routes do not pass through any residential areas. Access to the Refinery is via a security controlled access point with the main entrance located on Refinery Road. Access to the site from Refinery Road is via the Prospecton Road (followed by East Avenue) which can be accessed off the N2. The South Coast Road and N2 off-ramps are characterised by a significant traffic load throughout the day. However, traffic congestion is primarily experienced at major intersections during peak times only.

A baseline description of road traffic assessment was compiled as part of a previous EIA (Cleaner Fuels, 2013) based on traffic counts at the two main Prospecton Road intersections along the main access route from the N2 to SAPREF. At the time of the assessment both intersections had ample spare capacity during both morning and afternoon peak periods; this is unlikely to have changed significantly in the interceding period due to low levels of development within the region.

5 SCOPING OF POTENTIAL ENVIRONMENTAL IMPACTS

An interactions matrix was used as a scoping tool to identify which interactions between the project components and environmental resources/receptors were likely to result in environmental impacts (**Table 14**).

Where no significant impact source or interaction exists (denoted with '*') the potential environmental impact is scoped-out as per the detailed justifications in **Section 5.1.1**.

Where impact sources and potentially significant impacts exist (denoted with '✓') the potential environmental impact is assessed in **Section 5.2**.

Table 14: Interactions Matrix

POTENTIAL IMPACT SOURCE			BIOPHYSICAL RESOURCES									SOCIO-ECONOMIC RESOURCES						
	CONSTRUCTION	OPERATION	GEOLOGY	SOIL	SURFACE WATER	GROUNDWATER	MARINE ENVIRONMENT	TERRESTRIAL ECOLOGY	AMBIENT AIR QUALITY	AMBIENT NOISE	CLIMATE	ECONOMY AND	SOCIAL AND CULTURAL	SOCIAL INFRA. AND	OCC. HEALTH AND	COMMUNITY HEALTH &	COMMUNITY SAFETY	REGULATORY	CULTURAL HERITAGE
Land Transformation	✓																		x
Atmospheric Emissions	✓	✓							x							x			
Greenhouse Gas (GHG) Emissions	*																		
Noise Emissions	*	✓								x						x			
Hazardous Substances	✓	*		x	x														
Major Accidental Hazard (MAH)	*																		
Solid Waste	✓	*		x	x										x			x	
Effluent	*																		
Water Consumption	*																		
Change in Aesthetics	*	✓														x			
Light Emissions	*	✓											x						
Traffic and Transportation	*																		
Work in Hazardous Environments	✓	✓													x				
Employment	✓	*										x							

5.1.1 JUSTIFICATION FOR 'SCOPING OUT' OF IMPACT SOURCES AND INTERACTIONS

GREENHOUSE GAS EMISSIONS

During construction there will be a negligible increase in direct and indirect GHG emissions associated with electricity usage and small fuel burning appliances (e.g. electrical generators).

During operation, the replacement flare will not directly result in changes in GHG emissions from the refinery. It is noted that a small increase in GHG emissions will occur as a result of the constant purge of fuel gas or MRG immediately downstream of the seal drum. While this is a separate and ongoing project that does not require Environmental Authorisation, it is noted that the GHG emissions associated with the constant purge is negligible, calculated as 4.2e-5 of SAPREF's total Scope 1 GHG emissions (**Table 15**).

Table 15: GHG Emissions

EMISSION PARAMETER	VALUE	COMMENT
SAPREF's DEA allocated carbon budget	6,559,477 tCO2e	-
Contribution from Flaring	23,113 tCO2e	0.0007% of SAPREF's DEA allocated carbon budget
Purge contribution to flaring based on methane rich gas	281 tCO2e	1.21% of contribution from flaring 4.2e-5 of SAPREF's DEA allocated carbon budget

NOISE (CONSTRUCTION PHASE)

Construction activities will not be continuous in nature, with only some equipment active at any given time. On an indicative basis, the following noise sources have been identified during the construction phase: earth moving equipment (bull-dozers, front end loaders, graders, scrapers, etc.); material handling equipment (concrete mixers, cranes, etc.); power units (generators, compressors, etc.); other equipment (compressed air blowers, power saws, electric drills, etc.); and power equipment (pile drivers, pneumatic breakers, grinders, etc.). Due to the relatively low noise levels and distances of the construction areas to the refinery boundary no significant changes in noise levels are anticipated at the refinery boundary.

HAZARDOUS SUBSTANCES (OPERATIONAL PHASE)

The operational phase will not include the storage and/or handling of hazardous substances. No impacts are anticipated.

WASTE MANAGEMENT (OPERATION)

The only waste that has the potential to be generated is a small quantity of gas purge gas filters. Spent filters will be managed via existing SAPREF waste management procedures.

MAJOR ACCIDENTAL HAZARDS (MAH)

The refinery is designated as a MHI. In terms of the MHI Regulations it is necessary to undertake a risk assessment at existing MHIs prior to all modifications due to the change in procedures and capacity.

The North Flare replacement project is not associated with any existing major hazard risk sources at the refinery. Whilst vent gas and MRG are both flammable substances, only minor changes to the pipework configurations will be made at the base of the flare; there will be no significant change in quantities.

Flare is designed according to API520 to ensure process safety. As a conservative safety feature, the MRG pipeline will be designed for much higher pressures than the actual MRG pressure.

EFFLUENT GENERATION

No effluent will be generated during the construction phase.

WATER CONSUMPTION

Negligible quantities of water will be required for construction purposes (in relation to existing water consumption at the refinery).

The current total water demand of the refinery is 8801t/day comprising reclaimed water (from the eThekwini Southern Works water reclamation facility) and potable water from the municipal supply. The only water requirement for the flare is linked to steam supply. Based on the steam additional requirement the increase to current water consumption will be c. 0.02% which is considered marginal and not a significant water resource efficiency issue.

CHANGE IN AESTHETICS (CONSTRUCTION)

For the most part, the replacement flare will be assembled on the ground whilst the existing flare remains in operation; therefore there will be no change in aesthetics during construction associated with the flare structure itself. The crane that will be utilised for lifting the new flare into position is likely to be visible from off-site viewpoints. However, due to the existing highly industrialised setting of the refinery, this will not constitute a significant change in aesthetic.

LIGHT EMISSIONS / LIGHT POLLUTION (CONSTRUCTION)

The project will not involve the use of major light sources.

TRAFFIC AND TRANSPORTATION

Increased vehicular traffic during construction is likely to be associated only with the delivery of equipment and removal of waste materials for off-site disposal. The quantities of materials for the project are relatively small; loads will be intermittent, and therefore no significant increase road traffic is anticipated.

There is no traffic or transportation associated with the operational phase of the flare.

WORK IN HAZARDOUS ENVIRONMENTS

During construction and operation the labour workforce / SAPREF personnel may be involved in high risk activities including:

- Working at heights
- Working in proximity to mechanical equipment and machinery
- Working in proximity to an operational refinery with associated hazards
- Working in extreme weather conditions

The management of worker health and safety falls outside of the remit of the EIA Regulations and this BA Report; and the associated EMPr thus excludes mitigation measures. As with current operations, SAPREF is required to manage worker health and safety in accordance with the Occupational Health and Safety Act, 1993 (Act No. 85 of 1993).

6 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT

In this section the potential impacts of the project on the physical, biological and socio-economic environmental components has been assessed. The assessment is limited to the environmental components where potential interactions are present.

6.1 METHODOLOGY

6.1.1 ASSESSMENT OF SIGNIFICANCE

The assessment of impacts and mitigation evaluated the likely extent and significance of the potential impacts on identified receptors and resources against defined assessment criteria, to develop and describe measures that will be taken to avoid, minimise or compensate for any adverse environmental impacts, to enhance positive impacts, and to report the significance of residual impacts that occur following mitigation.

The key objectives of the risk assessment methodology are to validate impacts identified through a matrix, identify any additional potential environmental issues and associated impacts likely to arise from the proposed project, and to propose a significance ranking. Issues / aspects will be reviewed and ranked against a series of significance criteria to identify and record interactions between activities and aspects, and resources and receptors to provide a detailed discussion of impacts.

A standard risk assessment methodology was used for the ranking of the identified environmental impacts pre- and post-mitigation. The significance of environmental aspects was determined and ranked by considering the criteria presented in **Table 16**.

Table 16: Impact Assessment Criteria and Scoring System

CRITERIA	SCORE 1	SCORE 2	SCORE 3	SCORE 4	SCORE 5
Impact Magnitude (M) The degree of alteration of the affected environmental receptor	Very low	Low	Medium	High	Very high
Impact Extent (E) The geographical extent of the impact on a given environmental receptor	Site: Site only	Local: Inside activity area	Regional: Outside activity area	National: National scope or level	International: Across borders or boundaries
Impact Reversibility (R) The ability of the environmental receptor to rehabilitate or restore after the activity has caused environmental change	Reversible: Recovery without rehabilitation		Recoverable: Recovery with rehabilitation		Irreversible: Not possible despite action
Impact Duration (D) The length of permanence of the impact on the environmental receptor	Immediate: On impact	Short term: 0-5 years	Medium term: 5-15 years	Long term: Project life	Permanent: Indefinite
Probability of Occurrence (P) The likelihood of an impact occurring in the absence of pertinent environmental management measures or mitigation	Improbable	Low Probability	Probable	Highly Probably	Definite

ENVIRONMENTAL SIGNIFICANCE = (MAGNITUDE + EXTENT + REVERSIBILITY + DURATION) x PROBABILITY					
TOTAL SCORE	4 to 15	16 to 30	31 to 60	61 to 80	81 to 100
ENVIRONMENTAL SIGNIFICANCE RATING (-)	Very low	Low	Moderate	High	Very High
ENVIRONMENTAL SIGNIFICANCE RATING (+)	Very low	Low	Moderate	High	Very High

6.1.2 IMPACT MITIGATION

The following mitigation hierarchy (illustrated in **Figure 26**) was applied when proposing prevention, compensation and mitigation measures:

- **Avoid / Prevent:** Avoidance or prevention refers to the consideration of options in project location, siting, scale, layout, technology and phasing to avoid impacts on biodiversity, associated ecosystem services, and people. This is referred to as 'the best option', but it is acknowledged that avoidance or prevention is not always possible.
- **Minimise:** Minimisation refers to the consideration of alternatives in the project location, siting, scale, layout, technology and phasing that would minimise impacts on biodiversity, ecosystem services and people. As defined in IFC PS1; "acceptable options to minimise will vary and include: abate, rectify, repair, and/or restore impacts, as appropriate".
- **Rehabilitate / Restore:** Rehabilitation refers to the consideration of the rehabilitation of areas where impacts are unavoidable and measures are provided to return impacted areas to a near-natural state or an agreed land use.
- **Offset:** Offsetting refers to the consideration of measures over and above rehabilitation to compensate for the residual negative effects on biodiversity ecosystem services and people, after every effort has been made to minimise and then rehabilitate impacts.

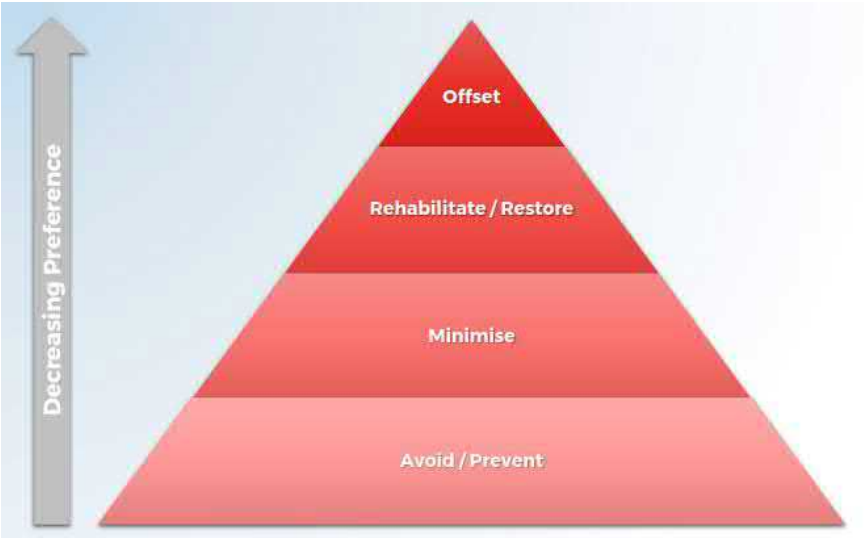


Figure 26: Impact Assessment Mitigation Hierarchy

6.2 RESULTS

6.2.1 LAND TRANSFORMATION

a) Potential for chance finds of cultural heritage resources (construction)

Impact Source:	During construction there may be temporary use of undeveloped (open) land in the area around the flare associated with the pre-construction of the flare prior to being lifted into position.
Impact Description:	The project is being undertaken on an existing industrial site. Previous investigations have indicated that there are no cultural heritage features present.
Mitigation:	Whilst no impacts are anticipated, it is nevertheless possible that a resource may be encountered during excavation activities, and therefore a chance find protocol is included within the EMPr (**Appendix G**).

Significance Rating:

Pre-Mitigation							Post-Mitigation						
(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
3	1	3	1	2	16	N2	3	1	3	1	1	8	N1
N2 - Low							N1 - Very Low						

6.2.2 ATMOSPHERIC EMISSIONS (CONSTRUCTION PHASE)

a) Localised air quality deterioration due to dust emissions from construction activities (construction)

Impact Source:	The use of vehicles and equipment in the work areas and the contractor laydown area has the potential to generate dust emissions. With the exception of very windy conditions these emissions are likely to be confined to the immediate area.
Impact Description:	Dust in the immediate area of the project which may be exacerbated during dry and/or windy conditions.
Mitigation:	— Limit vehicle speeds on un-surfaced areas. — Avoid dust-generating activities (i.e. grading and moving of soil) during windy periods. — Cover and/or maintain appropriate freeboard on trucks hauling any loose material that could produce dust when travelling. — Re-vegetate or hard surface disturbed areas as soon as possible to prevent excessive dust from occurring. — Dampen exposed soil to suppress dust if required. This will be undertaken by using lignosulphonate and/or water where possible.

Significance Rating:

Pre-Mitigation							**Post-Mitigation**						
(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
1	2	1	1	2	10	N1	1	2	1	1	1	5	N1
N1 - Very Low							N1 - Very Low						

6.2.3 ATMOSPHERIC EMISSIONS (OPERATIONAL PHASE)

ATMOSPHERIC IMPACT REPORT SUMMARY

Justification for AIR

The project will result in increases in emissions from the flare during flaring scenarios due to the increase of the flare design capacity. The increase in emissions has the potential to impact negatively (i.e. increase concentrations) of modelled pollutants at receptor locations.

The increase in the flare stack height will generally have the effect of improving the dispersion of emissions into the atmosphere. In isolation, this has the potential to impact positively (i.e. decrease concentrations) of modelled pollutants at receptor locations.

The overall environmental impact of the project considers both of the above mechanisms.

Modelling Methodology

Air quality environmental aspects are referenced from the AIR contained in **Appendix C**.

A Level 3 modelling assessment was undertaken in line with the *Modelling Regulations*. Level 3 modelling assessments are recommended for:

- Understanding air quality impacts, including spatial and temporal variation in concentrations;
- Ensuring causality effects, calms, non-linear plume trajectories, spatial variations in turbulent mixing, multiple emission source types and where chemical transformations need to be accounted for; and
- Informing air quality management approaches that involve multi-source, multi-sector contributions from permitted and non-permitted sources in an airshed.

The CALPUFF model was used, which is the recommended Level 3 model in the *Modelling Regulations*. CALPUFF is a multi-layer, multi-species non-steady-state puff dispersion model, which can simulate the effects of time and space, as well as varying meteorological conditions on pollutant transport, transformation and removal.

Receptors

Discrete receptors selected for the study are listed in **Table 6-17**. Receptors were selected based on proximity to the study site and are places where sensitive individuals may be impacted, such as residences, schools or medical facilities. Their proximity to SAPREF is shown in **Figure 6-27**.

Table 6-17: Discrete receptor locations

ID	Receptor Name	Receptor Type	Distance (km)	Direction	Latitude (°S)	Longitude (°E)
1	Wentworth	Residential	5.1	NE	-29.934249°	30.988975°
2	Ganges	Residential/School	2.9	N	-29.948745°	30.964660°
3	Settlers	Residential/School	2.3	NE	-29.958304°	30.978449°
4	Merewent	Residential/Hospital	2.0	NE	-29.962897°	30.979413°
5	Isipingo Beach	Residential	3.0	SW	-29.996238°	30.944404°
6	Prospecton	Residential	4.5	SW	-30.002804°	30.928808°
7	Isipingo	Residential	4.1	SW	-29.982001°	30.922085°
8	Umlazi	Residential	3.0	NW	-29.963087°	30.937861°

Figure 6-27: Sensitive receptors

Operational Scenarios Modelled

Dispersion modelling simulations of PM_{10}, NO_2, SO_2 and VOCs was undertaken for short-term (i.e. 24-hour and 1-hour) averaging periods for comparison with applicable NAAQS. Model outputs showed simulated pollutant concentrations experienced at ground level for the following scenarios:

1. Worst case scenario: Emergency depressuring of HDS4 (baseline, flare balancing);
2. Worst case scenario: Emergency depressuring of HDS4 (proposed, no flare balancing)
3. Planned shutdown (baseline, based on 2020 shutdown data, flare balancing); and
4. Planned shutddown (proposed, based on 2020 shutdown data but adjusted for no flare balancing).

Further details on the selected emission scenarios are provided in the AIR (**Appendix C**).

Background Air Quality Data (for cumulative impact assessment)

Ambient air quality monitoring data has been sourced from three monitoring stations in the region, namely Wentworth, Ganges and Settlers. All stations are owned and managed by the eThekwini Metropolitan Municipality. Data for the period January 2017 – December 2019 was assessed for compliance with applicable NAAQS. A minimum data recovery of 90% is required for assessing compliance with national standards[5]. With the exception of the Wentworth station (i.e. PM_{10} measured during 2019), data recovery across the pollutant array measured by all stations failed to meet this requirement. Nonetheless, in the absence of any other site relevant monitoring data, the available information has been used to provide insight into background pollutant concentrations in the study area. The results presented in the sections below must be considered in the context of low data recovery. Where hourly concentrations were provided in parts per billion (ppb), these were converted to micrograms per cubic metre ($\mu g/m^3$) using temperature and pressure for the corresponding date and hour as

[5] South African National Accreditation System (SANAS, 2012) in *TR 07-03*

measured by the SAWS meteorological station. Station information and data recovery is presented in detail in the AIR.

SUMMARY OF RESULTS OF THE AIR QUALITY IMPACT ASSESSMENT

a) Off-site air quality impacts (operation)

Impact Source:	Flaring is an important operational and safety measure at petroleum refining facilities, particularly during non-routine operational periods such as malfunction or upset, to prevent the build-up of pressure in the refinery system. The emissions from flaring events are non-continuous; therefore, the AIR is based on the assessment of air quality impacts during short term events under the following scenarios: 3) **Worst case emergency scenario** ** – Emergency depressurising of the HDS4 unit to a fire at the unit. *** Shell is one of SAPREF key shareholders and must comply with the Shell control framework. This compliance must be demonstrated on a yearly basis. Part of the Shell control framework is the process safety management where SAPREF focuses on design integrity (all design and build processes must ensure that risks are as low as reasonably practicable (ALARP)); technical integrity; and, operating integrity.* *Hazard and operability studies (HAZOP) are undertaken as part of the design of projects – this includes the north flare replacement project, and the previously undertaken HDS4 reactor replacement project (which is linked to the worst case flaring scenario). HAZOP is a structured and systematic examination of a complex planned or existing process or operation in order to identify and evaluate problems that may represent risks to personnel or equipment.* *All designs are based on legal requirements and the strictest recommendations of the international refinery standards.* *Maintenance strategies are adopted for all projects and long term actions are implemented. During operation SAPREF executes risk based inspections and operates according its safe and reliable operating windows.* 4) **Planned refinery shutdown** - a scheduled event wherein all process units at the refinery are taken off stream for an extended period for maintenance. Shutdowns at SAPREF occur every 2 years. This frequency will be reduced to every 4 years post 2022. The shutdown period is 24 hours.
Impact Description:	Findings of the AIR can be summarised as follows **Worst case emergency scenario** The emergency depressuring of HDS4 is an upset condition resulting in a worst-case emission scenario from the North Flare. Even when combining this worst-case emission scenario with the worst-case meteorological scenario, the ambient contributions from the North Flare do not result in exceedances of any pollutants at any sensitive receptors, except for 1-hour average Ganges and Umlazi (proposed flare) (402.47ug/m^3 and 576.76ug/m^3 respectively vs. NAAQS of 350ug/m^3). At Wentworth the baseline flare exceeds the NAAQS (402.47ug/m^3 vs. NAAQS of 350ug/m^3), however the proposed flare is compliant (152.05.47ug/m^3 vs. NAAQS of 350ug/m^3 It is important to note that the exceedences above are limited to the duration of the flaring event i.e. non-continuous and short term in nature - the technical data provided by SAPREF (depressuring curves) show that the emission event peaks within 15 minutes. In addition, the modelling is conservative as it is based on the flaring event coinciding with the worst case meteorological hour across the record for a specific receptor. The probability of this occurrence is very low (less than 0.004%).

Planned refinery shutdown

A planned shutdown occurs every 2 years at the facility. This frequency will be reduced to every 4 years post 2022. A cumulative (facility-wide) emission scenario was assessed, combining flare emission calculations with emissions from the other onsite point sources during a previous planned shutdown. Once again, the results are reflective of a short term event, and are conservative as they assume that the flaring event coincides with the worst case meteorological conditions. The likelihood that the worst case meteorological conditions would coincide with the day of shutdown at a specific point is very low (<0.27%).

1) Baseline and proposed receptor concentrations were predicted to be compliant with the PM10 and NO_2 NAAQS. There is no significant change in worst case ambient PM10, NO_2 or TVOC under the proposed scenario.
2) Worst case domain peak hourly NO_2 under the baseline and proposed scenarios exceeds the 1-hour NO_2 NAAQS at Ganges (219.22ug/m^3 vs. NAAQS of 200ug/m^3). This occurs in the vicinity of the railway. When assessing the P99 1-hour NO_2 concentrations (the concentration likely to occur 99% of the time), full compliance occurs across the model domain, therefore the exceedence is very unlikely.
3) Worst case 24-hour and 1-hour SO_2 concentrations are predicted to decrease (range between 0.19% and 5.30%) under the proposed scenario at all receptors, except worst case 24-hour average at Prospecton which increases by 2.15% (but remains complaint with NAAQS) and by 1.11% at Umlazi (exceeds the NAAQS), which is not significant within the confidence levels of the modelling.
4) While worst case simulations show a significant region of exceedance of the SO_2 NAAQS 24-hour limit under the baseline and proposed scenarios (ranging from 998ug/m^3 to 3702ug/m^3 vs. NAAQS of 350ug/m^3), an assessment of the P99 24-hour SO_2 concentrations (the concentration likely to occur 99% of the time) reveals compliance at all receptors except Isipingo Beach. A number of receptors (Settlers, Merewent, Prospecton, Isipingo and Umlazi) fall within NAAQS compliance when assessing the P99 1-hour SO_2 values.

Cumulative Assessment

A cumulative assessment combining ambient monitoring data with the model simulations was attempted. Due to significant gaps in the monitoring data, there are no cumulative results for PM10, NO2 or TVOC.

Data was available in the Ganges monitoring record to assess cumulative concentrations at the time of the worst case 24-hour and worst case 1-hour SO_2 simulations. The cumulative concentrations exceed the NAAQS under both scenarios. The conservatism in assessing the incidence of a planned shutdown during worst-case meteorological conditions is highlighted - these results offer a worst-case scenario. Importantly, the cumulative worst case 24-hour and 1-hour SO_2 concentrations at Ganges decrease (9.24% and 82.6% respectively) under the proposed scenario. This can be explained by the increased height of the North Flare, which improves the likelihood of dispersion before emissions reach ground level.

Conclusion

The AIR shows that the potential for short-term SO_2 exceedances at sensitive receptors during flaring incidents at SAPREF. However, these occur when combining a conservative emission scenario with worst case meteorological conditions which is very improbable. It is more likely than not that a planned shutdown will occur during meteorological conditions that promote effective dispersion and do not result in ambient exceedances at sensitive receptors.

Importantly, the proposed increased height of the North Flare decreases the likelihood of exceedances at sensitive receptors, due to increased dispersion of emissions before reaching ground level.

Mitigation:	**Worst case emergency scenario** – Ensure project design mitigates risks to as low as reasonably practicable (ALARP). – Existing process safety management systems to be continued in order to reduce the risk unplanned unit downtime and unit trips which lead to unplanned flaring events. **Planned refinery shutdown** – Reduce the frequency of planned flaring events by changing major shutdowns to a 4-year cycle post 2022.

Significance Rating:

Pre-Mitigation							Post-Mitigation						
(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
5	3	5	1	1	14	N1	5	3	5	1	1	14	N1
N1 - Very Low							N1 - Very Low						

6.2.4 NOISE EMISSIONS

a) Changes in off-site ambient noise levels due to flare sound power levels (SPL) (operation)

Impact Source:	The existing refinery flares are identified as a potential noise source associated with the refinery operations (Apex Environmental Noise Report, 2020). No sound power level (SPL) information (i.e. decibels at 1m) is available for the existing flare, however it is anticipated that the SPL is in excess of 85dB(A). The replacement flare will utilise up-to-date technology, which will result in lower noise emission than the existing flare. Whilst the final SPL of the replacement flare will be specified by the technology supplier, the maximum SPL specification is 85dB(A). The replacement flare is therefore expected to reduce off-site ambient noise levels during the operational phase.
Impact Description:	The predicted change (reduction) in off-site ambient noise levels could not be calculated due to the absence of SPL data for the current North Flare. Screening sound level propagation calculations based on an SPL of 85dB(A) at 1m indicate that the proposed flare will have a negligible have a negligible contribution to cumulative contributions at the refinery boundary (**Table 18)**. This will be an improvement to the current situation where flaring at SAPREF is a significant contributor to off-site noise levels during unplanned and planned flaring events – this is based on 1) results of Apex Noise Monitoring Report (2015) identifying flare noise as being discernible from monitoring locations; and, 2) SAPREF complaints register (up to September 2020) implicating flares in several of the complaints attended to by SAPREF.

Table 18: Screening-level sound propagation calculations

DETERMINANT	VALUE
Boundary	North Boundary (closest to residential Areas)
Distance from Source (NZ Flare)	587m
NZ Flare Sound Power Level (db(A))	85 (at 1m)
Absolute Contribution	29.6
Existing Off-Site Ambient Noise Level (dB(A)) (Apex, 2020)	68.1
Cumulative Contribution (dB(A)) based on existing Refinery Sources *	0.0006
* due to the inclusion of the existing North Flare in the 2020 monitored data the levels are expected to be higher than in the replaced flare scenario. This results in the contribution in the table being slightly understated.	

Mitigation:	– Maintain existing noise monitoring programme / obtain confirmatory monitoring data regarding reduction in ambient noise levels during flaring events. – Reduce the frequency of planned flaring events by changing major shutdowns to a 4-year cycle post 2022. – Reduced the frequency of unplanned events by operational monitoring and maintenance of equipment to ensure reliability and reduce unit upsets.

Significance Rating:

Pre-Mitigation							**Post-Mitigation**						
(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
3	2	1	1	4	28	P2	3	2	1	1	4	28	P2
P2 - Low							P2 - Low						

6.2.5 HAZARDOUS SUBSTANCES

a) Soil and groundwater contamination due to accidental spillage of small quantities hazardous substances (construction)

Impact Source:	Construction activities have the potential to generate stormwater contaminated with sediment, and oil and grease from machinery. Construction activities also have the potential to result in the handling and storage of additional waste materials which may be contaminated.
Impact Description:	There is potential for localised contamination of the soil due to accidental spills of hazardous substances outside of secondary containment.
Mitigation:	**Preventative Management** – Provide and utilise drip trays for immobile vehicles and machinery that will be operated on site. – Acquire spill kits to clean up any hydrocarbon or chemical spills during closure to prevent seepage. – Storage of hazardous materials if any, should be undertaken within impermeable bunded, ventilated and covered storage areas, capable of containing 110% of total volume. **Spill and Incident Management** – Spill and response equipment must be accessible on-site. – Suitable spill containment must be provided for transfer points outside of bunded areas. – Spillages / leaks are to be contained immediately; deploy oil containment berms if the spill migrates to other areas. – Cover the spill with absorbent material. – Remediation of the spill areas will be undertaken to the satisfaction of the Environmental Manager. – Dispose of the clean-up material in line with MSDS requirements of spilled material. – Staff handling hazardous substances / materials must be aware of the potential impacts and follow appropriate safety measures. Appropriate PPE must be made available.

Significance Rating:

Pre-Mitigation							**Post-Mitigation**						
(M+	**E+**	**R+**	**D)x**	**P=**	**S**	**Rating**	**(M+**	**E+**	**R+**	**D)x**	**P=**	**S**	**Rating**
2	1	1	1	2	**10**	**N1**	2	1	1	1	1	**5**	**N1**
N1 - Very Low							**N1 - Very Low**						

b) Soil and Groundwater contamination associated with the handling of potential latent subsurface contamination (construction)

<table>
<tr><td>Impact Source:</td><td>There is potential for the identification of latent (historical) subsurface contamination during construction related excavations; however these will be very limited in nature.</td></tr>
<tr><td>Impact Description:</td><td>If excavated material is found to be contaminated and is not handled correctly, it would have the potential to cause occupational health and safety risks as well as environmental impacts on soil, groundwater and surface water.</td></tr>
<tr><td>Mitigation:</td><td>– All excavated material must be considered as ‘potentially hazardous waste’ whether intended for backfilling/reuse on site or spoiling off-site. Confirmatory sampling must be undertaken and the results analysed to obtain representative determination of the presence of contamination.
– In the event that material is contaminated it must be treated as hazardous waste and classified in accordance with GN. R635 (National Norms and Standards for the Assessment of Waste for Landfill Disposal). Specifically, the re-use and disposal of contaminated material on-site is not permitted.
– The above mitigation does not release SAPREF from compliance with the current legislation concerning the assessment and remediation of contaminated land under the National Environmental Management Waste Act (2008).</td></tr>
<tr><td>Significance Rating:</td><td>
<table>
<tr><th colspan="7">Pre-Mitigation</th><th colspan="7">Post-Mitigation</th></tr>
<tr><td>(M+</td><td>E+</td><td>R+</td><td>D)x</td><td>P=</td><td>S</td><td>Rating</td><td>(M+</td><td>E+</td><td>R+</td><td>D)x</td><td>P=</td><td>S</td><td>Rating</td></tr>
<tr><td>3</td><td>1</td><td>1</td><td>1</td><td>2</td><td>12</td><td>N1</td><td>3</td><td>1</td><td>1</td><td>1</td><td>1</td><td>6</td><td>N1</td></tr>
<tr><td colspan="7">N1 - Very Low</td><td colspan="7">N1 - Very Low</td></tr>
</table>
</td></tr>
</table>

6.2.6 SOLID WASTE GENERATION

a) Soil and groundwater contamination associated with waste generation and handling (construction)

Impact Source: The construction process is anticipated to generate small quantities of typical general and hazardous waste streams as shown in **Table 19**. These wastes will be collected and managed by a SAPREF approved waste management contractor and disposed at an approved 3rd party facility in accordance with the South African waste management legislation.

Table 19: Typical Construction Waste

Waste Category	*Waste Type*	*Typical Constituents*
General Waste	Domestic Waste	Paper and cardboard packaging, empty plastic and metal containers (non-hazardous original contents) etc.
	Mixed Industrial	Wood, plastic, packaging etc.
	Metal Waste	Ferrous and non-ferrous scrap including the material removed during the dismantling of the existing flare.
Hazardous Waste	Oily Waste	Used lubricant and hydraulic oils and hydrocarbon based solvents produced during the maintenance of mechanical equipment
	Oil Contaminated Waste	Solid material (rags etc.) that has come into contact with and contains traces of oil or grease
	Excavated material	It is noted that the subsurface conditions beneath the Refinery may be contaminated. Therefore, excavated material (e.g. from trenches, earthworks) that is required to be spoiled will be considered potentially hazardous (subject to confirmatory waste classification).

Impact Description: There is potential for minor/localised surface/groundwater and soil contamination due to inadequate waste handling.

Mitigation:

- Waste should be stored in separate and secure skips / containers depending on management options – opportunities should be determined, in consultation with waste service providers, for re-use, recycle, or disposal options.
- Hazardous waste (including used oils and material containing oils, solvents, empty chemical containers etc.) should be undertaken within impermeable bunded and ventilated storage areas, capable of containing 110% of total volume. All storage containers are to be labelled, sealed and stored in accordance with Material Safety Data Sheet (MSDS) or Safety Data Sheet (SDS) requirements.
- General waste should be stored within waste skips within a designated area with consideration given to stormwater management.

Significance Rating:

Pre-Mitigation							**Post-Mitigation**						
(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
3	1	1	1	2	12	N1	3	1	1	1	1	6	N1
N1 - Very Low							N1 - Very Low						

6.2.7 CHANGE IN AESTHETICS

b) Change in aesthetics from off-site viewpoints associated with the increase in flare height (operation)

<table>
<tr><td>Impact Source:</td><td>The proposed flare will be 17.7m higher than the existing flare. This change is likely to be visible from off-site viewpoints including the nearby communities.</td></tr>
<tr><td>Impact Description:</td><td>There are various existing stacks of greater height and diameter to the replacement flare, including the existing South Flare that is c. 100m in height (i.e. more than the proposed height of the new flare). Therefore the proposed increase in flare height does not constitute a significant change in aesthetic and is unlikely to result in any negative effects to off-site person’s including the nearby communities.</td></tr>
<tr><td>Mitigation:</td><td>— No mitigation proposed.</td></tr>
<tr><td>Significance Rating:</td><td>
<table>
<tr><th colspan="7">Pre-Mitigation</th><th colspan="7">Post-Mitigation</th></tr>
<tr><td>(M+</td><td>E+</td><td>R+</td><td>D)x</td><td>P=</td><td>S</td><td>Rating</td><td>(M+</td><td>E+</td><td>R+</td><td>D)x</td><td>P=</td><td>S</td><td>Rating</td></tr>
<tr><td>1</td><td>2</td><td>1</td><td>1</td><td>1</td><td>5</td><td>N1</td><td>1</td><td>2</td><td>1</td><td>1</td><td>1</td><td>5</td><td>N1</td></tr>
<tr><td colspan="7">N1 - Very Low</td><td colspan="7">N1 - Very Low</td></tr>
</table>
</td></tr>
</table>

6.2.8 LIGHT EMISSIONS

a) Light pollution associated with increase light emissions from the flare flame (operation)

<table>
<tr><td>Impact Source:</td><td>The increased capacity of the flare will also result in an increase in the size, and consequently the amount of light emitted from the flame, resulting in a potential for light pollution. Light pollution effects typically include nuisances in nearby community areas when light intrudes into bedroom windows, upward light resulting in sky glow) and glare when intense light sources are viewed directly. The potential for increase in light emissions as a source of impacts is evaluated below:
— API 537 Guidelines (Flare Details for Petroleum, Petrochemical, and Natural Gas Industries, 2017) guidelines do not specify any requirements regarding luminosity or brightness of the flare. Environmental and health and safety issues are limited to atmospheric emissions, noise, and thermal radiation.
— No information on flare luminosity is available from the flare equipment supplier as this is not considered a common technical or EHS performance metric.
— The luminosity associated with refinery flares is not identified as a significant impact associated with petroleum refineries according to the World Bank Environmental, Health, and Safety Guidelines for Petroleum Refining (World Bank, 2016).
The suburban community and industrial areas surrounding the refinery are intrinsically bright environments due to existing artificial light sources (street lights, mast lighting, industrial lighting etc.) and are therefore unlikely be sensitive to changes in light levels (albeit that significant changes are not expected in the case of the current project). Moreover, the absence of community complaints associated with light pollution from the refinery during the 2015 – 2020 (September) period, indicates that this is not an existing impact that could be exacerbated by the project.</td></tr>
</table>

Impact Description:	The potential for increased light emissions from the flare as a source of impacts has been evaluated as low. In addition, the suburban community and industrial areas surrounding the refinery are intrinsically bright environments due to existing artificial light sources (street lights, mast lighting, industrial lighting etc.) and are therefore unlikely be sensitive to changes in light levels (albeit that significant changes are not expected in the case of the current project). The absence of community complaints associated with light pollution from the refinery during the 2015 – 2020 (September) period indicates that this is not an existing impact that could be exacerbated by the project.
Mitigation:	– Maintain existing complaints register as a grievance mechanism for identifying any future light pollution issues. – Reduce the frequency of planned flaring events by changing major shutdowns to a 4-year cycle post 2022. – Reduced the frequency of unplanned events by operational monitoring and maintenance of equipment to ensure reliability and reduce unit upsets.

Significance Rating:

Pre-Mitigation							**Post-Mitigation**						
(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
1	2	1	1	1	5	N1	1	2	1	1	1	5	N1
N1 - Very Low							N1 - Very Low						

6.2.9 EMPLOYMENT

a) Indirect employment opportunities within contracting firms in the construction phase (construction)

Impact Source:	The construction phase will result in the creation of a limited number of employment opportunities to the contractors. This will indirectly contribute to employment generation and sustainability. As these numbers are indirect they cannot be accurately quantified.
Impact Description:	The project will create limited indirect employment opportunities within contracting firms in the construction phase. These may lead to improvement in the financial income and potential for improved living standards of employed individuals and households.
Mitigation:	– Tender processes must include the prioritisation of local businesses contractors and labour throughout the construction phase, where feasible. – All contractors will be obliged to use local labour where possible.

Significance Rating:

Pre-Mitigation							**Post-Mitigation**						
(M+	E+	R+	D)x	P=	S	Rating	(M+	E+	R+	D)x	P=	S	Rating
3	3	1	1	5	40	P3	3	3	1	1	5	40	P3
P3 - Moderate							P3 - Moderate						

7 CONCLUSION AND RECOMMENDATIONS

7.1 SUMMARY OF IMPACT ASSESSMENT

The BA process has found that both construction and operational phases of the proposed project will involve activities which will lead to a limited number of direct and indirect impacts (negative and positive) on the biophysical and socio-economic environment. These impacts were found to vary in terms of their consequence and probability. Where appropriate, mitigation measures to reduce the negative impacts, and enhance positive impacts have been proposed, and detailed in the EMPr (**Appendix D**).

Both the initial and residual (post-mitigation) significance of impacts have been presented in **Section 5.1.1.** So as to obtain an indication of the effectiveness of the mitigation measures

7.2 CONCLUSION

The overall objective of the BA process was to provide sufficient information to enable informed decision-making by the authorities. This was undertaken through consideration of the proposed project components, identification of the aspects and sources of potential impacts and subsequent provision of mitigation measures.

All negative potential environmental and social impacts associated with the project have been assessed as having very low significance (residual i.e. assuming that mitigation is implemented). In addition the project will result in positive impacts in terms of off-site ambient noise levels and local economic opportunities.

Mitigation measures have been developed where applicable for the above aspects and are presented within the EMPr. It is imperative that all impact mitigation recommendations contained in the EMPr are implemented.

It is the opinion of WSP that the project should be authorised; and, that information contained in this BA Report is sufficient for an informed decision to be made.

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APPENDIX

A PLACEHOLDER FOR STAKEHOLDER ENGAGEMENT REPORT ** FINAL BA REPORT ONLY

APPENDIX

B EAP CURRICULUM VITAE

APPENDIX

NIGEL SEED, B.Soc.Sc. EAP

Director (Environmental Science), Environment & Energy

Years with the firm

19

Years of experience

19

Areas of expertise

Environmental and Social Impact Assessment (ESIA)

Environmental and Social Due Diligence (ESIA)
Environmental and Social Management Systems (ESMS)

ENV-ID Assessment of Industrial Processes

Environmental Legal Compliance (South Africa)

CAREER SUMMARY

Nigel has 19 years' environmental and social consulting experience. He is a Technical Director as well as the Africa lead for the environmental and social impact assessment (ESIA) service and Power in Africa.

Nigel has led complex ESIA and transaction related due diligence assessments across a range of sectors including aerospace, agro-processing, chemicals, healthcare, infrastructure (ports, roads, waste management), manufacturing, mining and beneficiation, oil & gas, pulp & paper power generation (thermal & renewables), and property development.

Nigel has extensive experience working with national and international regulations and procedures, including Equator Principles III, the IFC Performance Standards on Environmental and Social Sustainability (2012) and related policies, and the World Bank Group EHS and Industry Sector guidelines.

Nigel has experience in Angola, Cameroon, Ghana, Kenya, Lesotho, Madagascar, Mozambique, Nigeria, Somalia (Somaliland), South Africa, Swaziland and Zambia.

EDUCATION

Bachelor of Social Science, Environmental Management & Geography, University of Natal, Durban, South Africa	2000

ADDITIONAL TRAINING

Nuclear Engineering Short Course (Reactor Technology), South African Network for Nuclear Education, Science and Technology (SAN-NEST).	2017
Resettlement as Part of Impact Assessment, Intersocial Consulting Ltd. c/o IAIA	2017
ISO 9001:2015 Awareness workshop, DQS Training Academy	2016
Understanding International Project Finance, International Project Finance Association	2016
Hazard Identification and Risk Assessment Training, EOH Legal Services	2015
Diploma in AutoCAD	2000

PROFESSIONAL MEMBERSHIPS

Certified Environmental Assessment Practioner	EAP
Institute for Waste Management South Africa	IWMSA
International Association for Impact Assessment	IAIA

PROFESSIONAL EXPERIENCE

Environmental Impact Assessment Process

Crude Oil Refining

- Tetra Ethyl Lead Facilities Decommissioning Projects, South Africa (2012 - 2015). Client: SAPREF.
- Hydrogen Manufacturing Unit (HMU), South Africa (2019). Client: SAPREF

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- Tetra Ethyl Lead Facilities Decommissioning Projects, South Africa (2012 - 2015). Client: SAPREF.
- Environmental Due Diligence (EDD) for the proposed acquisition of a bulk petrochemical depot (2015). South Africa. Client: Confidential Black Economically Empowered Private Equity Investor
- ESIA for the Expansion of the 90 000 bpd SAPREF Crude Oil Refinery to achieve EURO 5 Fuel Specifications, South Africa, (2013). Client: SAPREF.
- Environmental Legal Appraisal of Refinery Projects, South Africa (2012-2014). Client: SAPREF.
- Waste Act Legal Review of SASOL Synfuels Refinery, South Africa (2013-2014). Client: SASTECH.
- Industry Waste Management Plan for the South African Used Lubrication Oils Sector, South Africa (2015). Client: ROSE Foundation.

Mining, Beneficiation and Processing

- Lenders Environmental and Social Due Diligence for proposed term loan finding of the Vanchem Assets (2016). Client: Nedbank Limited.
- Site Screening and Environmental and Social Impact Assessment for the establishment of calcium carbonate calcining facilities (2017). Client: Grasland Ondernemings.
- Lenders Environmental and Social Due Diligence for the Accra Cement Grinding Facility (2016). Accra, Ghana. Client: DEG
- Underground Chrome Mine, South Africa (2011). Client: Samancor Chrome Ltd.
- South Uranium Plant SX Circuit Replacement, South Africa (2011). Client: AngloGold Ashanti (Pty) Ltd.
- Smelter SO_2 Abatement Projects, Polokwane / Rustenburg, Limpopo / North West Province, South Africa (2012). Client: Anglo American Platinum Ltd.
- Desulpherisation Unit, Newcastle, KwaZulu-Natal, South Africa (2006). Client: Arcelor Mittal South Africa Ltd.
- 60 MVA Ferrosilicon Smelter, South Africa (2003). Client: Silicon Technology (Pty) Ltd.
- Richards Bay Bulk Materials Handling Facility ESIA, South Africa (2003). Client: Richards Bay Coal Distributors.

Effluent and Waste Management

- Waste management plan for all Total South Africa manufacturing, commercial, retail and administration facilities located in South Africa, Namibia, Botswana and Swaziland (2016). Client: Total South Africa Limited.
- Waste management plan for all PPC cement manufacturing and quarry sites in South Africa (2016). Client: PPC Limited.
- Waste management plan for all Transnet Port Terminal sites in South Africa (2015). Client: Transnet Port Terminals.
- Netcare National Waste Management Strategy, South Africa (2015). Client: Netcare Limited.
- Healthcare Risk Waste Treatment Facilities, Pietermaritzburg, KwaZulu-Natal, South Africa (2006-2009). Client: Ecocycle (Pty) Ltd.
- Electron Road Regional Waste Transfer Station, South Africa (2005-2006). Client: Durban Solid Waste.
- KwaDukuza waste disposal site, South Africa (2010). Client: Metamorphosis Environmental Consultants.

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- Illovo South Africa Waste Legislation Compliance Review and Strategy, South Africa (2010). Client: Illovo Sugar South Africa Limited.
- Waste Disposal Site Prefeasibility, South Africa (2010). Silicon Technology (Pty) Ltd.
- Newcastle Works Effluent Buffering, South Africa (2009). Client: Arcelor Mittal South Africa Ltd.
- AngloGold Waste Management Strategy, Vaal River, Gauteng, South Africa (2008). Client: AngloGold Ashanti (Pty) Ltd.
- Lebowa Mining Complex Waste Management Strategy, South Africa (2008). Client: Anglo American Platinum Ltd.
- Umbogintwini Industrial Complex Effluent Balance, South Africa (2007-2008). Client: Heartland Leasing (Pty) Ltd.
- Resource Recovery Facility – Uitenhage, Eastern Cape, South Africa (2007-2008). Client: Veolia Environmental Services (Pty) Ltd.
- Effluent Treatment Facilities, South Africa (2007/8). Client: SAPREF.
- Study on Priority Hazardous Waste Streams in the Western Cape, South Africa (2007). Client: Department of Environmental Affairs and Development Planning.
- Hazardous Waste Transfer Facility, Richards Bay, KwaZulu-Natal, South Africa (2006). Client: Transnet Port Terminals.
- Logmed® Medical Waste Facilities, South Africa (2002). Client: WasteMan (Pty) Ltd.

Power

- QMM Hybrid Wind, Solar and BESS Power Project, Madagascar (2020). Client: CrossBoundary Energy
- E&S Red Flags Due Diligence for Multi-regional Renewable Energy Portfolio, South Africa (2020). Client: Confidential International Investor.
- E&S Red Flags Due Diligence for a portfolio of three Hybrid (Wind, Solar and BESS) Dispatchable Energy Projects South Africa (2020). Client: Nedbank, RMB, ABSA
- E&S Red Flags Due Diligence for the 400MW Richards Bay Gas II (RBG2) Project. South Africa (2020). Client: Nedbank c/o Fieldstone
- Integrated battery energy storage facility (BESS), South Africa (2020). Client: Gridflex Energy.
- Garneton Solar PV Projects, Zambia (2020). Client: AfDB.
- Environmental advisory services in relation to IFC requirements for a 550MW Open Cycle Gas Turbine (OCGT) Power Plant project in Ondo State, Nigeria (2019). Client: Kingline Development Nigeria.
- Environmental and social review of the Ndeke Solar PV development site extension area, Zambia (2018). Client: IFC
- Environmental and social screening of prospective solar PV and thermal (gas) power generation sites, Nacala, Mozambique (2018). Client: Confidential
- Lenders ESDD for the Aggeneys and Konkoonsies Solar Renewable Energy Projects (2016). Client: Nedbank Ltd.
- ESIA for the 120MW combined cycle gas turbine power project and associated Light Crude Oil and Natural Gas pipelines and storage facilities in the Tema Free Zone Enclave in Ghana (2016). Client: Atlantic Electric Company / LMI Holdings.

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- ESIA for Photovoltaic and Concentrated Solar (trough) Power Generation Facilities in Northern Cape Province, South Africa (2015). Client: Biotherm Energy.
- ESIA for Wind Power Generation Facilities in Western Cape Province, South Africa (2015). Client: Biotherm Energy.
- Gledhow Mill 11-18MW Biomass Energy Project, South Africa (2012). Client: Illovo Sugar Ltd.
- Solar Photovoltaic (PV) Generation Facility, South Africa (2011). Client: eThekwini Municipality Energy Office.
- National Landfill Gas to Electricity Projects, South Africa (2009-2010). Client: CEF (Pty) Ltd.
- Durban Solid Waste Landfill Gas to Electricity Projects, South Africa (2003-2004). Client: Durban Solid Waste.
- Sasolburg 180-200MW Combined Cycle Gas Engine Power Project, South Africa (2011). Client: SASOL New Energy Holdings.
- Sappi Saiccor 20MW Multi-Fuel Boiler, South Africa (2011). Sappi Southern Africa Limited.
- Sappi Tugela 40MW CCGT Project, South Africa (2011) Client: Sappi Southern Africa Limited.
- Power Line Construction and Upgrading projects, South Africa. Client: eThekwini Electricity Department.

Food and Agriculture

- Ubombo Mill Furfural project, Swaziland (2015). Client: Illovo Southern Africa.
- ESIA Screening and TOR for Tea Manufacturing Facility, Kenya (2011). Client: Unilever Limited.
- Yeast Plant Environmental Prefeasibility, South Africa and Swaziland (2011). Client: AB Mauri Technology & Development Ltd.
- Waste Management Licensing, Stanger, KwaZulu-Natal, South Africa (2010). Client: Sappi Stanger (Pty) Ltd.

Manufacturing Sector

- LignoTech Acquisition E&S Due Diligence, South Africa (2010). Client: LignoTech SA
- Mondi Richards Bay Chemical Plant Upgrade Project (2019). Client: Mondi Limited.
- Mondi Richards Bay Mill Expansion Project (2017). Client: Mondi Limited.
- Environmental, Health and Safety Due Diligence for the acquisition of domestic and industrial geyser manufacturing firm (2016). Client: Confidential Scandinavian Investor.
- Anhydrous Hydrofluoric Acid Plant, South Africa (2012). Client: Foskor (Pty) Ltd. Lead Auditor.
- MSMA Production, South Africa (2009). Client: Mzanzi Chemicals (Pty) Ltd.
- PET Plant Debottlenecking - South Africa (2007-2008). Client: HOSAF (Pty.) Ltd.
- Biodiesel Manufacturing, Berlin, Eastern Cape, South Africa (2007). Client. CleanTech Africa.
- Industry Waste Management Plan, Western Cape, South Africa (2007) Client. Western Cape Department of Environmental Affairs.

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- Ferromanganese Storage, Durban, KwaZulu-Natal, South Africa (2006). Client: Transnet National Ports Authority.
- Acrylic Emulsion Plant Debottlenecking, South Africa (2006). Client: Rohm and Haas (Pty) Ltd.
- Solid State Polymerisation (SSP) plant upgrade, Durban, KwaZulu-Natal, South Africa (2004): Client: HOSAF (Pty.) Ltd.
- Di Methyl Phthalate Plant Adaptation, South Africa (2003). Client: Orchem (Pty) Ltd.
- Lignosulphonate Plant Construction Project. South Africa (2003) Client: Lignotech (Pty) Ltd.

Municipal Infrastructure

- Esidweni Low Cost Housing, South Africa (2003). Client: eThekwini Housing Department.
- Le Domaine Sewage Scheme, South Africa (2003). Client: Le Domaine (Pty) Ltd.
- Mpumalanga Eastern Trunk Sewer, South Africa (2002). Client: eThekwini Wastewater Department / Stewart Scott Engineers.
- Sewage Treatment Facilities, Durban, KwaZulu-Natal, South Africa (2001). Client: Alliance Property Group.

Large Scale Infrastructure

- ESIA of the 485MW Kpep Hydropower Project, Cameroon Northwest Region (2019). Client: Joule Africa
- Nondovo Dam, Swaziland (eSwatini) (2019). Client: Government of eSwatini
- Lesotho Highlands Water Project Phase 2, Lesotho (2019). Client: Confidential.
- Berbera Port Phase 1 Expansion Project. Somalia (2018). Client: DP World
- Bakassi Deep Water Port, Cross River State, Nigeria (2018). Client: Cross River State.
- Pemba Oil and Gas Port and Logistics Centre, South Africa (2014). Client: Sonils/ENH.
- South Sudan Feeder Roads Environmental Review (2017). Client: United Nations Office for Project Services
- Outer West Roads Upgrades, South Africa (2005). Client: eThekwini Roads Department.
- Transnet Rail Engineering Waste Management Strategies, South Africa (2011). Client: Transnet Rail Engineering.
- Richards Bay Port Dry Bulk Terminal Waste Management Strategy, South Africa (2006). Client: Transnet Port Terminals.
- Richards Bay Port Dry Bulk Terminal Waste Transfer Station, South Africa (2006). Client: Transnet Port Terminals.
- Durban Port Upgrades of Island View Berths 5 and 6. South Africa (2005). Client: Transnet Port Terminals.
- Richards Bay Port Waste Management Strategy, South Africa (2004). Client: Transnet Port Terminals.
- Durban Port Ore and Ferrochrome Facility EMS, South Africa (2007). Client: Bridge Ports (Pty) Ltd.

APPENDIX

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Director (Environmental Science), Environment & Energy

General

- SAAB Gripen Legal Review, Durban, KwaZulu-Natal, South Africa (2006). Client: SAAB (c/o SAAB Sweden).
- South African Police Services EMS. St. Lucia Wetland Park, KwaZulu-Natal, South Africa (2007). Client: South African Police Services.

APPENDIX

C ATMOSPHERIC IMPACT REPORT (AIR)

APPENDIX

D ENVIRONMENTAL MANAGEMENT PROGRAMME REPORT (EMPR)