2023

EIA REPORT: Proposed Construction of Walvis Bay Oil Refinery on a Portion of Portion 9 of Farm No. 58, Walvis Bay, Erongo Region

1/23/2023

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LIST OF ACRONYMS

AIDS	Acquired immune deficiency syndrome
CRR	Comments and response report
dB	Decibels
DESR	Draft Environmental Scoping Report
EA	Environmental Assessment

EAP	Environmental Assessment Practitioner
EAR	Environmental Assessment Report
ECC	Environmental Clearance Certificate
ECO	Environmental Control Officer
EIA	Environmental Impact Assessment
EMA	Environmental Management Act
EMP	Environmental Management Plan
FESR	Final Environmental Scoping Report
ESR	Environmental Scoping Report
GTZ	Gesellschaft für Technische Zusammenarbeit
HIV	Human immunodeficiency virus
I&AP	Interested and Affected Party
IUCN	International Union for Conservation of Nature
MET	Ministry of Environment and Tourism
MEFT: DEA	Ministry of Environment, Forestry and Tourism: Department of Environmental Affairs
MURD	Ministry of Urban and Rural Development
MWTC	Ministry of Works Transport and Communication
PPP	Public participation process
p/km^2	People per square kilometre
SADC	Southern African Development Community

1. INTRODUCTION

1.1 Project Background

Clasox Petroleum (PTY) LTD is a duly registered company in Namibia. Clasox Petroleum (PTY) LTD established a partnership with Plama Refinery (PTY) Ltd, one of Bulgaria's largest and leading petroleum companies specializing in processing, refining, marketing and distribution of petroleum throughout Bulgaria.

Clasox Petroleum (PTY) Ltd, hereinafter referred to as the proponent, intends to build a modern oil refinery in Walvis Bay, Namibia. The project will be carried out in two distinct stages, each of which will have a duration of approximately 12 months.

Preliminary technical and marketing studies point to a viable project that has relevance across multiple sectors of the economy, as it aims to provide solutions to the country's energy needs. It does not only target the Namibian market but also has great potential to supply the regional fuel demand.

It is against this background that the JV has embarked on this opportunity to contribute towards energy self-sufficiency.

The process will be undertaken in terms of the gazetted Namibian Government Notice No. 30 Environmental Impact Assessment Regulations (herein referred to as EIA Regulations) of the Environmental Management Act (No 7 of 2007) (herein referred to as the EMA). The EIA process will investigate if there are any potential significant bio-physical and socio-economic impacts associated with the proposed development and related infrastructure and services.

The EIA process will also provide an opportunity for the public and key stakeholders to provide comments and participate in the process. It will also serve the purpose of informing the proponent's decision-making, and that of MEFT.

1.2 Project Location

Walvis Bay is the third largest town in Namibia and has the biggest port in the country which is recognized as one of the most important cargo ports on the African West Coast. It serves as the regional hub for the Southern African Development Community (SADC) considering that land-locked countries such as Botswana, Democratic Republic of Congo, Zambia and Zimbabwe get some of their imports from Europe and other countries through the port of Walvis Bay.

Namibia's infrastructure is among the best in the region with a road network known as Walvis Bay Corridors. The Walvis Bay Corridors are an integrated system of well-maintained roads and rail networks, accommodating all modes of transport, from the port of Walvis Bay via the Trans Kalahari, Walvis Bay-Ndola-Lumbumbashi corridor, Trans-Cunene and Trans-Oranje Corridors providing landlocked SADC countries access to the global market (WBCG, 2019).

A number of options for the actual site have been identified and discussed with the Walvis Bay municipality. The first site that is proposed is a 10ha portion of Portion 9 of Farm No. 58 located on the north-western boundary of Portion 9 of Farm No. 58, and east of Portion 3 of Farm No. 58, with a pipeline length of 13.8 km (See **Figure 2** below).

The second alternative will be another 10ha portion on the south-western corner of the Remainder of Farm No.58, where it meets with the eastern boundaries of Portion 8 of Farm No. 58 (See **Figure 3** below), this will result in a pipeline of 13.1 km in length to the bulk oil terminal. The first site on a Portion of Portion 9 of Farm No.58 (**Figure 1**) has been selected as the preferred site for this development. See **Figures 1,2 and 3** below for the locality maps of Walvis Bay and the development site.

Figure 1: Locality map of Walvis Bay

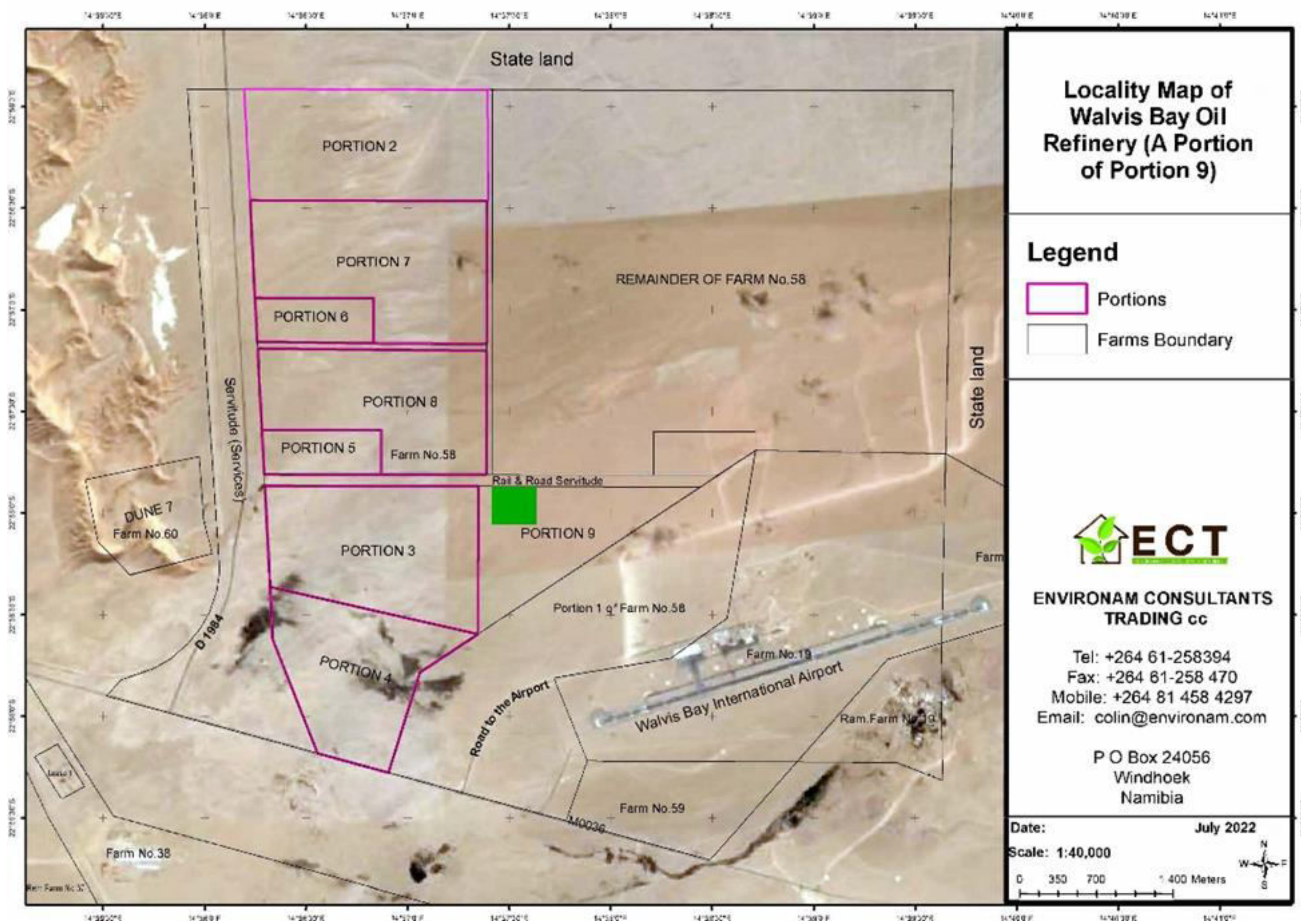

Figure 2: Locality map of the proposed development (Option 1)

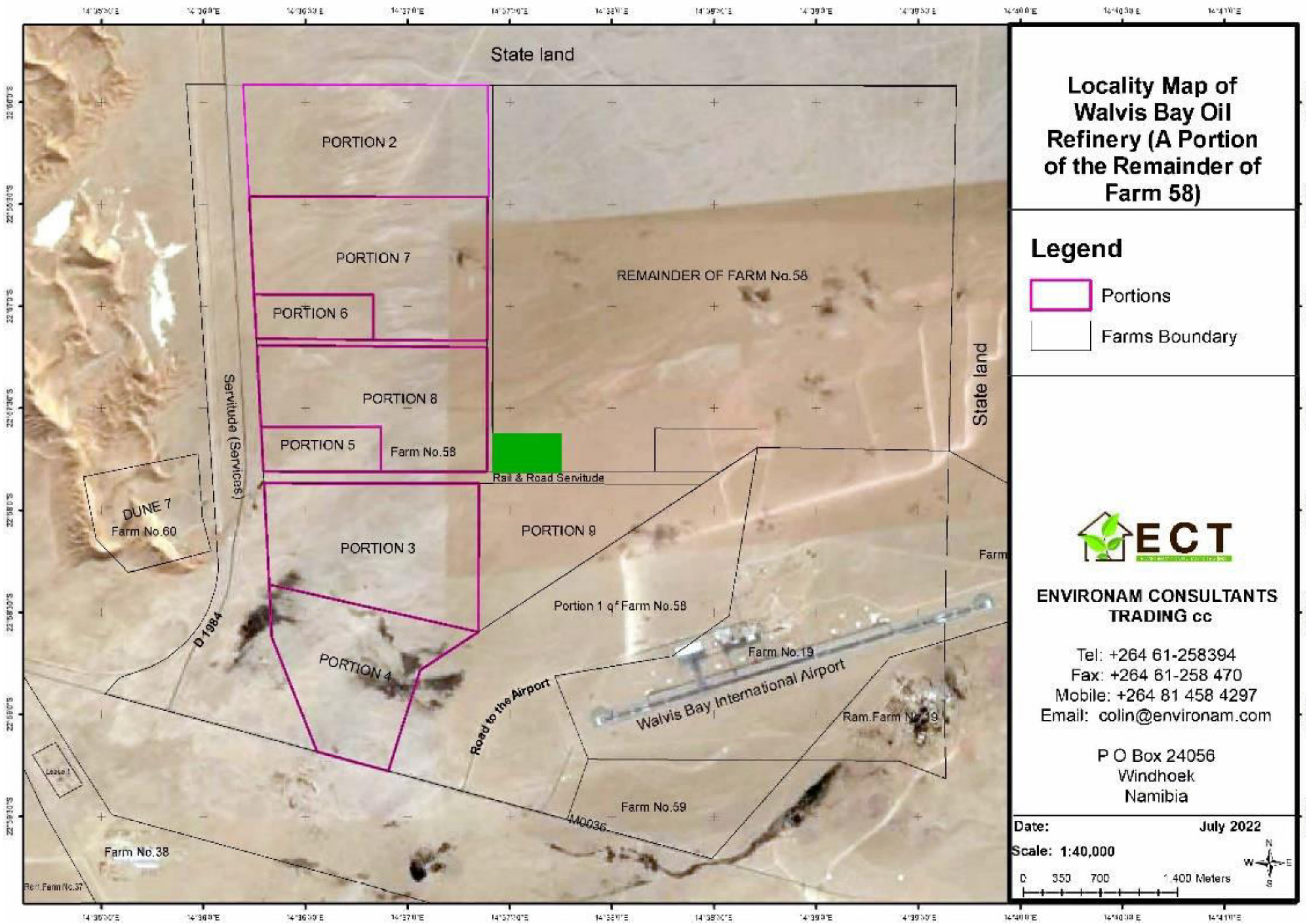

Figure 3: Locality map of the proposed development (Option 2)

1.3 Terms of Reference and Scope of Project

The scope of this project is limited to conducting an environmental impact assessment and applying for an Environmental Clearance Certificate for the Proposed Construction of Walvis Bay Oil Refinery on a Portion of Portion 9 of Farm 58, Walvis Bay, Erongo Region and associated infrastructure as indicated in section 1.1 above. This includes consultations with client; site investigations and analysis; stakeholder consultations; impact analysis; mitigation formulation; report writing; and draft Environmental Management Plan.

1.4 Assumptions and Limitations

In undertaking this investigation and compiling the Environmental Assessment, the following assumptions and limitations apply:

- Assumes the information provided by the proponent is accurate and discloses all information available.

1.5 Content of Environmental Scoping Report

In terms of Section 8 of the gazetted EIA Regulations certain aspects must be included in a Scoping Report. **Table 1** below delineate, for ease reference, where this content is found in the Environmental Scoping Report.

Table 1: Contents of the Scoping / Environmental Assessment Report

Section	Description	Section of ESR/ Annexure
8 (a)	The curriculum vitae of the EAPs who prepared the report;	Refer to **Annexure E**
8 (b)	A description of the proposed activity;	Refer to Chapter 4
8 (c)	A description of the site on which the activity is to be undertaken and the location of the activity on the site;	Refer to Chapter 3
8 (d)	A description of the environment that may be affected by the proposed activity and the manner in which the geographical, physical, biological, social, economic and cultural aspects of the environment may be affected by the proposed listed activity;	Refer to Chapter 3
8 (e)	An identification of laws and guidelines that have been considered in the preparation of the scoping report;	Refer to Chapter 2
8 (f)	Details of the public consultation process conducted in terms of regulation 7(1) in connection with the application, including	Refer to Chapter 5

Section	Description	Section of ESR/ Annexure
	(i) the steps that were taken to notify potentially interested and affected parties of the proposed application	Refer to Chapter 5
	(ii) proof that notice boards, advertisements and notices notifying potentially interested and affected parties of the proposed application have been displayed, placed or given;	Refer to **Annexures A** and **B** for site notices and advertisements respectively.
	(iii) a list of all persons, organisations and organs of state that were registered in terms of regulation 22 as interested and affected parties in relation to the application;	Refer to **Annexure D**
	(iv) a summary of the issues raised by interested and affected parties, the date of receipt of and the response of the EAP to those issues;	Refer to **Annexure D**
8 (g)	A description of the need and desirability of the proposed listed activity and any identified alternatives to the proposed activity that are feasible and reasonable, including the advantages and disadvantages that the proposed activity or alternatives have on the environment and on the community that may be affected by the activity;	Refer to Chapter 4
8 (h)	A description and assessment of the significance of any significant effects, including cumulative effects, that may occur as a result of the undertaking of the activity or identified alternatives or as a result of any construction, erection or decommissioning associated with the undertaking of the proposed listed activity;	Refer to Chapter 7
8 (i)	terms of reference for the detailed assessment;	Refer to Chapter 1
8 (j)	An environmental management plan	Refer to **Annexure F**

2. LEGAL, POLICY AND INSTITUTIONAL FRAMEWORK

The principle environmental regulatory agency in Namibia is the Office of the Environmental Commissioner within the Directorate of Environmental Affairs of the Ministry of Environment, Forestry and Tourism. Most of the policies and legislative instruments have their basis in two clauses of the Namibian Constitution, i.e. Article 91 (c) and Article 95 (l); however, good environmental management finds recourse in multiple legal instruments. **Table 2** below provides a summary of the legal framework considered to be relevant to this development and the environmental assessment process.

Table 2: Legislation applicable to the proposed development

LEGISLATION/POLICIES	RELEVANT PROVISIONS	RELEVANCE TO PROJECT
The Constitution of the Republic of Namibia as Amended	Article 91 (c) provides for duty to guard against "the degradation and destruction of ecosystems and failure to protect the beauty and character of Namibia." Article 95(l) deals with the "maintenance of ecosystems, essential ecological processes and biological diversity" and sustainable use of the country's natural resources.	Sustainable development should be at the forefront of this development.
Environmental Management Act No. 7 of 2007 (EMA)	Section 2 outlines the objective of the Act and the means to achieve that. Section 3 details the principle of Environmental Management	The development should be informed by the EMA.
EIA Regulations GN 28, 29, and 30 of EMA (2012)	GN 29 Identifies and lists certain activities that cannot be undertaken without an environmental clearance certificate. GN 30 provides the regulations governing the environmental assessment (EA) process.	**Activity 1 (c)** The construction of facilities for refining of gas, oil and petroleum products. **Activity 9.2** Any process or activity which requires a permit, licence or other form of authorisation, or the modifications of or changes to existing facilities for any process or activity which requires an amendment of an existing permit, licence or authorisation or which requires a new permit, licence authorisation in terms of a law governing the generation or release of emissions, pollution, effluent or waste. **Activity 9.3** The bulk transportation of dangerous goods using pipeline, funiculars or conveyors with a throughput of 50 tons or 50cubic meters or more per day. **Activity 9.4** The storage and handling of dangerous goods, including petrol, diesel, liquid petroleum gas or paraffin, in containers with a combined capacity of more than 30 cubic meters per day.

LEGISLATION/POLICIES	RELEVANT PROVISIONS	RELEVANCE TO PROJECT
		Activity 9.5 Construction of filling stations or any other facility for the underground and aboveground storage of dangerous goods, including petrol, liquid petroleum gas or paraffin. **Activity 10.1 (a)** The construction of oil, water, gas and petrochemical and other bulk supply pipelines. **Activity 10.1 (b)** The construction of – Public roads. **Activity 10.2 (a)** The route determination of roads and design of associated physical infrastructure where – it is a public road.
Convention on Biological Diversity (1992)	Article 1 lists the conservation of biological diversity amongst the objectives of the convention.	The project should consider the impact it will have on the biodiversity of the area.
Draft Procedures and Guidelines for conducting EIAs and compiling EMPs (2008)	Part 1, Stage 8 of the guidelines states that if a proposal is likely to affect people, certain guidelines should be considered by the proponent in the scoping process.	The EA process should incorporate the aspects outlined in the guidelines.
Namibia Vision 2030	Vision 2030 states that the solitude, silence and natural beauty that many areas in Namibia provide are becoming sought after commodities and must be regarded as valuable natural assets.	Care should be taken that the development does not lead to the degradation of the natural beauty of the area.
Water Act No. 54 of 1956	Section 23(1) deals with the prohibition of pollution of underground and surface water bodies.	The pollution of water resources should be avoided during construction and operation of the development.
The Ministry of Environment and Tourism (MET) Policy on HIV & AIDS	MET has recently developed a policy on HIV and AIDS. In addition, it has also initiated a programme aimed at mainstreaming HIV and gender issues into environmental impact assessments.	The proponent and its contractor have to adhere to the guidelines provided to manage the aspects of HIV/AIDS. Experience with construction projects has shown that a significant risk is created when construction workers interact with local communities.
Town Planning Ordinance 18 of 1954 (as amended by amongst others Town Planning Amendment Act 15 of 2000)	This Ordinance regulates rezoning of portions of land falling within a proclaimed Local Authority area.	The ordinance makes provision for the development of Town Planning Schemes.

LEGISLATION/POLICIES	RELEVANT PROVISIONS	RELEVANCE TO PROJECT
Walvis Bay Town Planning Scheme.	The town planning scheme has as its general purpose the co-ordinated and harmonious development of the local authority area, or the area or areas situate therein.	Procedures to manage zoning are stipulated in the Town planning Scheme.
Local Authorities Act No. 23 of 1992	The Local Authorities Act prescribes the manner in which a town or municipality should be managed by the Town or Municipal Council.	The development has to be comply with the provisions of the Local Authorities Act
Labour Act no 11 of 2007	Chapter 2 details the fundamental rights and protections. Chapter 3 deals with the basic conditions of employment.	Given the employment opportunities presented by the development, compliance with the labour law is essential.
Public Health Act no 36 of 1919	Section 119 prohibits persons from causing nuisance.	Developer and Contractors are to comply with these legal requirements.
Nature Conservation Ordinance no 4 of 1975	Chapter 6 provides for legislation regarding the protection of indigenous plants	Indigenous and protected plants have to be managed within the legal confines.
Atmospheric Pollution Prevention Ordinance (No. 11 of 1976).	The Ordinance objective is to provide for the prevention of the pollution of the atmosphere, and for matters incidental thereto.	All activities on the site will have to take due consideration of the provisions of this legislation.

This EIA process will be undertaken in accordance with the EIA Regulations. A Flow Diagram (refer to **Figure 4** below) provides an outline of the EIA process to be followed.

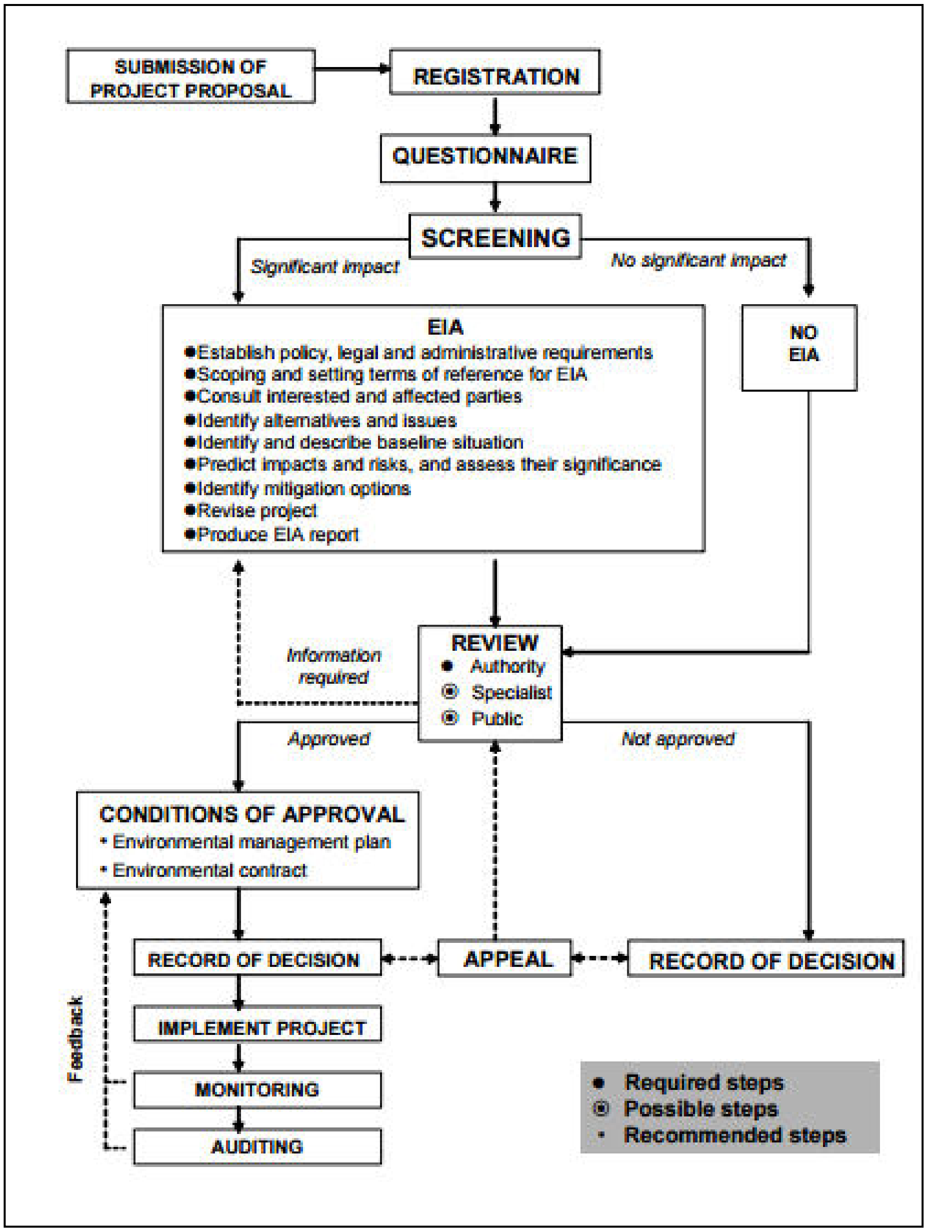

Figure 4: EIA Flowchart for Namibia (SELH, 2012)

3. ENVIRONMENTAL BASELINE DESCRIPTION

3.1. Social Environment

3.1.1. Socio-Economic Context

The statistics shown in **Table 3** below are derived from the 2011 Namibia Population and Housing Census (NSA, 2011):

Table 3: Statistics of Walvis Bay Urban Constituency

WALVIS BAY URBAN CONSTITUENCY	
Population	35,828
Females	16,478
Males	19,350
Private Households	10,317
Population under 5 years	10%
Population aged 5 to 14 years	14%
Population aged 15 to 59 years	72%
Population aged 60 years and above	
Female: male ratio	100:117
Literacy rate of 15 years old and above	99%
Head of household - Females	33%
Head of household - Males	67%
People above 15 years who have never attended school	3%
People above 15 years who are currently attending school	9%
People above 15 years who have left school	86%
People with disability	2%
People aged 15 years and up who belong to the labour force	81%
Population employed	73%
Homemakers	12%
Students	47%
Retired, too old etc.	40%
Income from pension	2%
Income from business and non-farming activities	9%
Income from farming	0%
Income from cash remittance	5%
Wages and salaries	80%

3.1.2. Archaeological and Heritage Context

While many archaeological sites have been found along the Namibian coast and some sites provide evidence of coastal occupation for a long time, many of these are considered “lucky finds” since the chances of artefacts surviving long and then being found are obviously small. As a result, the number of known archaeological sites with very old artefacts is few (Raison, 2016). It is unlikely that the development site will have any significant archaeological resources;

however, an accidental find procedure may be required. If any heritage or culturally significant artefacts are found during the construction, construction must stop and the National Heritage Council of Namibia immediately notified.

3.2. Bio-Physical Environment

3.2.1. Climate

Walvis Bay is considered to have a desert climate. During the year, there is virtually no rainfall. The Köppen-Geiger climate classification is BWk. In Walvis Bay, the average annual temperature is 16.6 °C. In a year, the average rainfall is 11 mm. The least amount of rainfall occurs in May. Most precipitation falls in March, with an average of 5 mm. The temperatures are highest on average in February, at around 19.2 °C. In September, the average temperature is 13.7 °C. It is the lowest average temperature of the whole year (Climate-data, 2019). See **Figure 5** for an average temperature graph and **Figure 6** for an average rainfall data for Walvis Bay.

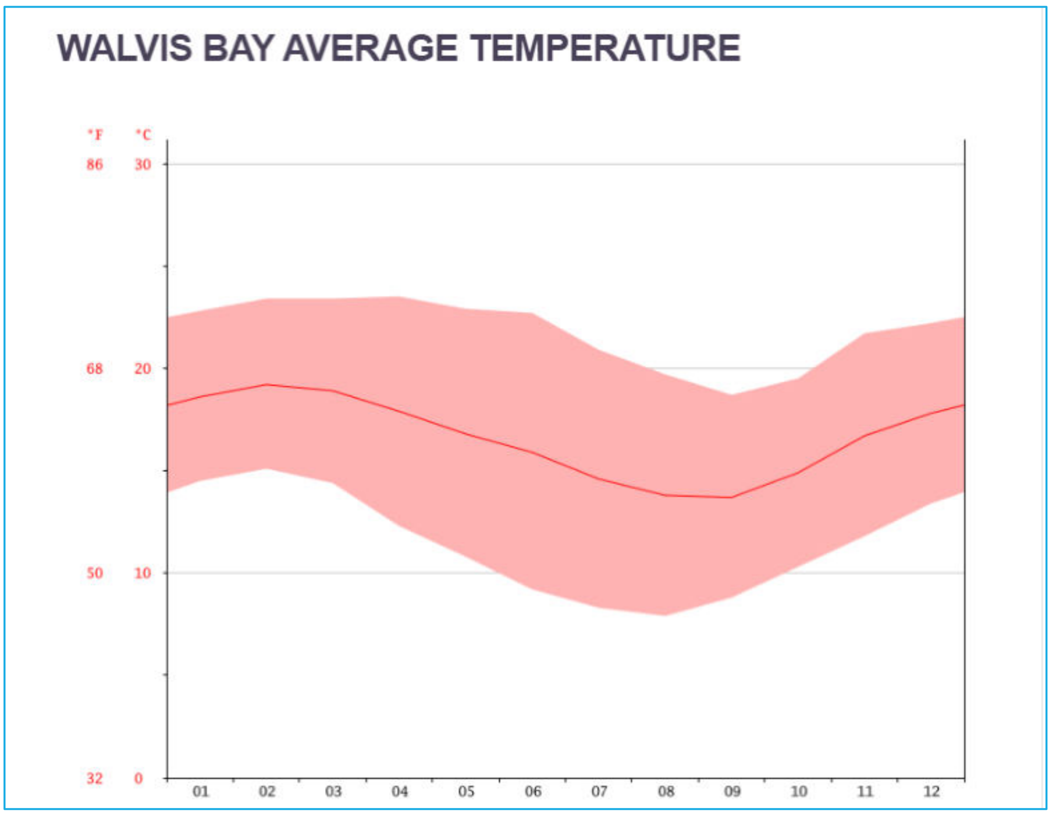

Figure 5: Average temperature graph for Walvis Bay (Climate-data, 2022a)

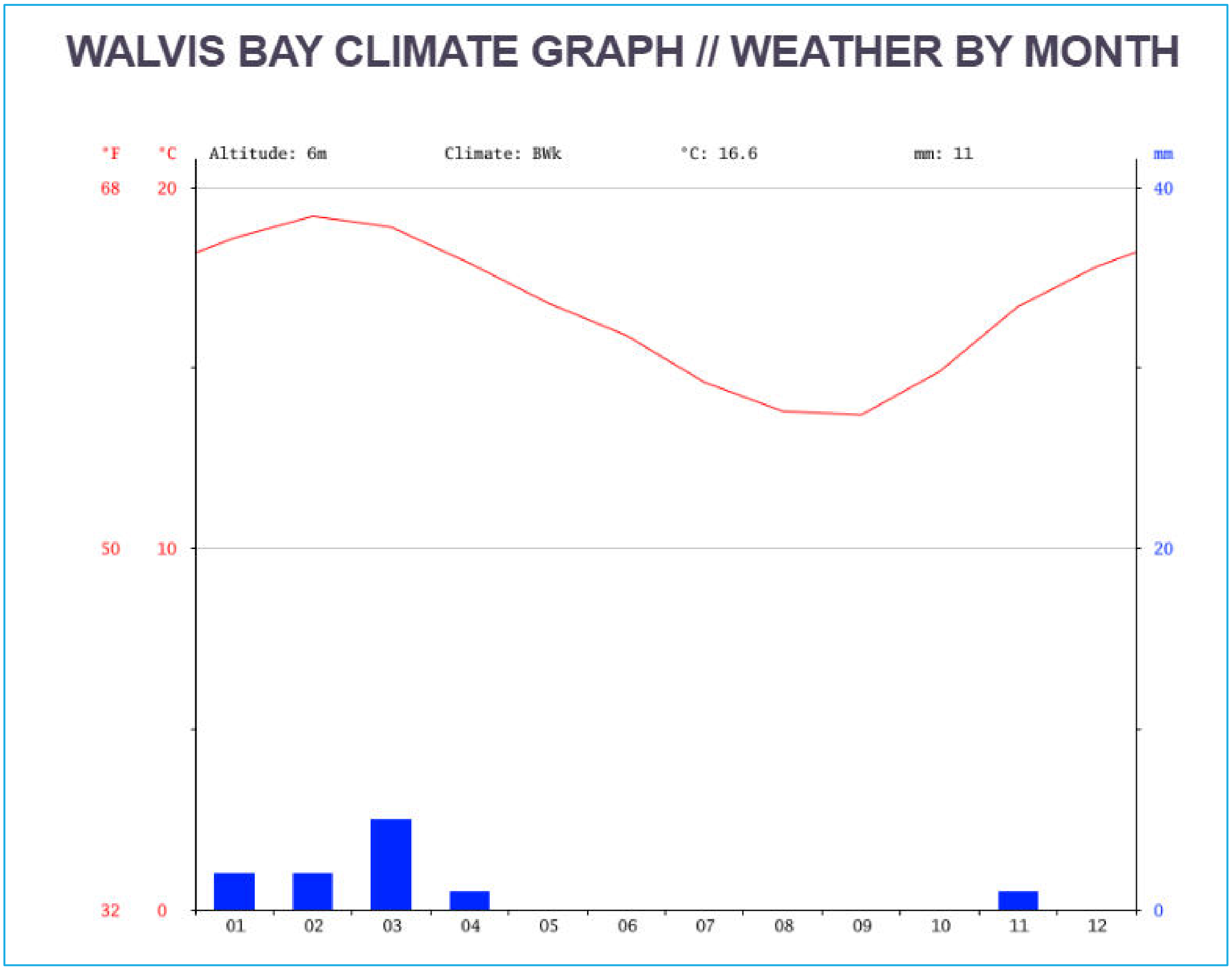

Figure 6: Average monthly rainfall graph for Walvis Bay (Climate-data, 2022b)

3.2.2. Topography, Geology and Hydrogeology

The Erongo Region, stretches from the Central Plateau westwards across the Central-Western Plains and Escarpment to the Central Namibian coast roughly over a distance between 200 and 350 km, and Northwards from the Ugab River in the north to the Kuiseb river in the south over a distance of up to 300 km, covers an area of 63,586 km^2, which is 7.7 per cent of Namibia's total area of about 823,680 km^2. On the Western side it is flanked by the Atlantic Ocean. Erosion cutting eastwards into the higher ground led to the formation of the Central-Western Plains, leading to the formation of the catchment area of several major ephemeral rivers such as the Khan, Omaruru, Swakop and Ugab, the water of these rivers reaches the sea when in full flood during a good rainy season (ERC, 2020).

The Southern boundary of the Kuiseb River distinctively divides the gravel plains to the North and the large sea of dunes to the South, however this river does not reach the sea during times of flood but the water instead disappears into the sand at the Kuiseb Delta, from which the town of Walvis Bay extracts underground water for its supplies.

In the Erongo Region, the land rises steadily from sea level to about 1,000 m across the breadth of the Namib. The Namib land surface is mostly flat to undulating gravel plains, punctuated with occasional ridges and isolated 'inselberg' hills and mountains. The eastern edge of the Namib is marked by the base of the escarpment in the southern part of the region. In the northern part, the escarpment is mostly absent and there is a gradual rise in altitude to over 1,500 m (SAIEA, 2011). The proposed site on which the development will be undertaken can be described as relatively flat.

The desert geology consists of sand seas near the coast, while further inland there is an occurrence of gravel plains and scattered mountain outcrops. Some of the highest sand dunes, up to around 300 m high, can be found here (ERC, 2020). Water for domestic and industrial use in Walvis Bay comes mainly from the Kuiseb aquifer in the lower Kuiseb River. These aquifers are recharged by runoff from the central highlands in central Namibia where rainfall is more reliable and more significant than at the coast (Nacoma, 2010).

3.2.3. Terrestrial Ecology

The bare gravel plains within an area of about 40 km of the coast, receive frequent fog moisture providing an ideal home to rich growths of lichens, many of which are endemic to Namibia. Lichen helps to bind the soil rendering it less vulnerable to wind erosion, they do this by forming a "carpet" on the surface pavement of small stones and gravel, or by creating a surface crust on the soil (Nacoma, 2010). No vegetation could be found on the proposed sites which is bare for the most part.

Some endemic coastal invertebrates and reptiles inhabit a narrow belt of dune hummocks within the Namibian coastal strip. This zone also supports marine life and surf zone species. Damara terns, which are near endemic to Namibia and near threatened, are found in concentrated numbers along the coastline stretching from south of Walvis Bay to about the Ugab river, where they nest on gravel plains within 3 – 5 km of the shore and forage over the shallow Bay water, over reefs or in salt ponds (Nacoma, 2010).

There are artificially high densities of jackals and gulls due to the increase in numbers of seal colonies and line fishermen which apply heavy predator pressure on the nesting terns. The central Namib coast is also home to the two vulnerable flamingo species, the greater and the lesser (Nacoma, 2010). There are no protected or red data listed plants or animal species found on the site. **Figure 7** below provides a view of the general area and surrounds of the proposed development site.

Figure 7: General area of the proposed development site.

3.3. Surrounding Land Use

The proposed site is mostly surrounded by undeveloped land that is earmarked for further Industrial developments, as allocations have been done for the remaining portions. On the eastern side is where the Walvis Bay International Airport is found. On the western side the landmark Dune 7 can be seen. On the western border of Farm No. 58 is the D1984 towards Swakopmund, including a railway servitude. The second phase of the Walvis Bay Interchange which is in progress also runs along the western border of Farm No. 58.

3.4. Physical Environment

The bulk service infrastructure needs of the proposed project can be categorised into two broad stages, before full operation.

Stage 1: 24-30 months (Design, drawings, tender, construction) Bulk Services

- Roads
- Water
- Sewer
- Electricity
- Fuel Lines
- Top structures related to the refinery (offices, ablutions, bunded area for tank farm)

- Life and fire safety concept note

Stage 2: (15-18 months) (Design, drawings, tender, construction) Extension to the Refinery

- Additional tanks
- Additional Atmospheric Vacuum, Distillation unit

A summary of water and electricity demand is provided below:

1. **Water**

   1.1 Stage 1

   - 1650m^3 of water is required for cooling and 100m^3 for steam generation.
   - 1560m^3 of cooling water will be recycled daily.
   - The plant will require 190m^3 of water for daily operations with 90m^3 lost in cooling and 100m^3 lost in the steam production.
   - The plant is designed not to contaminate water but should this occur due to any unforeseen reason, the water will be contained separately and disposed of via an authorised third party.

   1.2 Stage 2

   - 5500m^3 of water is required for cooling and 700m^3 for steam generation.
   - 5225m^3 of cooling water will be recycled daily.
   - The plant will require 975m^3 of water for daily operations with 275m^3 lost in cooling and 700m^3 lost in the steam production.
   - The plant is designed not to contaminate water but should this occur due to any unforeseen reason, the water will be contained separately and disposed of via an authorised third party.

   1.3 Full operation

   - 7150m^3 of water is required for cooling and 800m^3 for steam generation.
   - 6785m^3 of cooling water will be recycled daily.
   - The plant will require 1165m^3 of water for daily operations with 365m^3 lost in cooling and 800m^3 lost in the steam production.
   - The plant is designed not to contaminate water but should this occur due to any unforeseen reason, the water will be contained separately and disposed of via an authorised third party.

2. **Electricity**

   - Stage 1 will require 12000KWh per day
   - Stage 2 will require 25620kwh per day
   - Total requirement when fully operational is 37620KWh per day
   - A 1MW PV plant is envisaged for the development

There is a consideration to extend bulk water services to the site from the existing Namwater pipeline found in the development area, although technical details have to be discussed with Namwater and the proponent's design team as there, reportedly, appear to be challenges with water pressure from the pipeline. The proponent intends to construct a new waste water treatment plant to manage sewer and waste water generated from the activities of the development.

The municipality also has long-term plans to provide waste water facilities in the area, it is therefore advisable that the developer engages the Municipality to discuss options for cost sharing. Electricity will be provided to the site in consultation with the regional electricity distributor, ErongoRED. Ingress will initially be obtained from the road towards the Walvis Bay International Airport in the short term. A rail and road servitude has been provided for along the northern border of Portion 3 of Farm 58, as well as another one further north along Portion 8 of Farm 58. These will make it possible for long term access to this and other developments in Farm 58. The red arrows in **Figure 8** below indicates the short-term access into portion 4 of Farm 58 from the Walvis Bay International Airport Road and the long-term access north of Portions 3 and 8 of Farm 58.

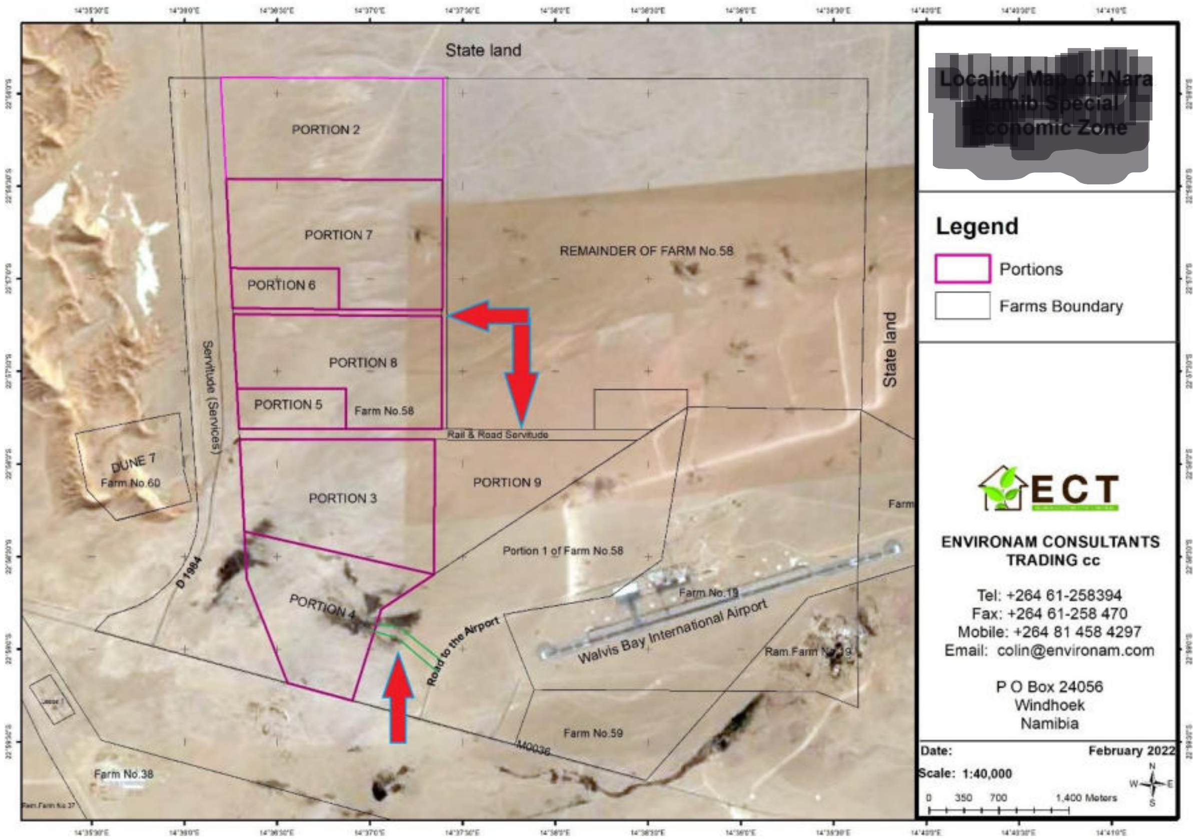

Figure 8: Short and long-term access to the development

4. PROJECT DESCRIPTION

4.1. Site Description

As previously outlined in Section 1.1, the proposed project involves the development of a modern oil refinery in Walvis Bay Namibia. The project will be carried in two distinct stages, each of which will have a duration of approximately 12 months.

Petroleum refineries separate crude oil into a wide array of petroleum products through a series of physical and chemical separation techniques. These techniques include fractionation, cracking, hydrotreating, combination/blending processes, and manufacturing and transport. The refining industry supplies several widely used everyday products including petroleum gas, kerosene, diesel fuel, motor oil, asphalt, and waxes (HSRC, 2003).

4.2. Process and Plant Description

4.2.1 Atmospheric Distillation Unit

4.2.1.1 Supply of Oil Tanks and Oil Preheating

Crude oil is temporary stored in refinery tanks, from where it is pumped to the Atmospheric Distillation Unit by feed pumps 100-P101 A/B, with an approximate pressure of about 14 barg and temperature of about 25oC. Before entering the distillation unit (before 100-P101 A/B), antifoulant is injected in the crude oil, for reducing side fouling caused by coke, polymers, sludge, corrosion products, tar and other particulate matter. The chemical is pumped from the Antifoulant Storage Drum (100-V104) to the injection point by the Antifoulant Injection Pump, 100-P115 A.

At the inlet of the unit, crude oil passes through a train of seven heat exchangers, where the energy available in the system is utilized to rise the crude oil temperature. The train raises the crude temperature from 25oC to about 267oC. Temperature of the streams in each heat exchanger is carefully monitored, because it gives indications about the fouling, outside or/and inside of the tubes. The train consists of the following heat exchangers: 100-E101 A/B, 100-E105, 100-E104, 100-E110, 100-E118, 100-E117 which work as follows:

- 100-E101 A/B, with the top vapours from the atmospheric distillation column;
- 100-E104, with atmospheric gasoil (pump around) from 100-P104 A/B;
- 100-E105, with atmospheric gasoil product from 100-P105 A/B;
- 100-E110, with Transformer Distillate product from 100-P111 A/B;
- 100-E117, with vacuum residue (pump around) from 100-P107 A/B;
- 100-E118, with vacuum residue product, from 100-P108 A/B.

The crude oil flow rate is controlled by the controller FIC 100-120, acting on control valve FV 100-120. It compares the actual flow rate with the set point and if there exists a difference between them, the controller sends a signal to the control valve FV 100-120, which adjust the flow rate. If the flow rate is higher than the set point, the signal from FIC 100-120 will close the valve. Otherwise, if the flow rate is lower, it will open it.

4.2.1.2 Crude Heater

In order to raise the temperature of the crude, up to the necessary temperature of its distillation (330oC), a Crude Heater (100-H1) is placed after the preheat train. The heat exchange occurs in a convective section first and in a radiant section afterwards. The heat is supplied by burning liquid fuel (vacuum residue).

Heater 100-H1, besides increasing oil temperature up to the entry level in the column 100-C101, also produces superheated steam required for stripping crude oil, in column 100-C101, and atmospheric gasoil, in side stripper 100-C104. For this purpose, a coil is placed in the convection section of the heater.

Depending on the manufacturer's advice, the heater may be forced draft or natural draft. Forced draft assumes air blowers and combustion air preheating. Natural draft heaters have a simpler construction, but instead require a tight control during start-up sequence by the operating staff to prevent formation of explosive mixtures inside the heater, or to delay the firing until these mixtures are eliminated.

To determine the pollutants in respect to environmental laws, nozzles are provided to sample the flue gas in the base stack and from exhaust flue gas.

The main control objectives of the heater's Combustion Control are:

- To supply fuel according to heat demand (heater outlet temperature).
- Maintain sufficient excess air to ensure complete combustion and safe operating conditions.
- Optimize excess of air to maximize fuel efficiency.

The control scheme has been designed such that when an increase in duty is required the air flow rate is increased before the fuel gas flow rate is increased. In addition, when a decrease in heater duty is required the fuel gas is reduced prior to the air flow rate being reduced (cross-limited arrangement). In this way a sufficient amount of combustion air is guaranteed at all times during operation.

The furnace outlet temperature is controlled by the TIC 100-216. This controller sets the heat demand and acts on the firing through the control valve TCV1. This temperature is also influenced by the excess of air which needs to be adjusted according to the recommendations of heater's manufacturer, neither high nor low, for the combustion to be complete. In case of incomplete combustion, CO (a toxic gas) is produced.

The superheated steam temperature used for stripping light components from liquid products is controlled by TIC 100-289. The objective of this controller is to keep a constant temperature in the superheated steam at heater outlet, by acting on two control valves (TV 100-281A and TV 100-281B). TIC 100-289 compares the desired value (set point fixed by operator) and the measured temperature. The controller signal modifies the opening percentage on TV 100-281A and TV 100-281B respectively, depending on its value. If the temperature measure is lower than its set point, the controller will tend to close TV 100-281A and will open TV 100-281B, in order to increase the steam flow through fired heater.

4.2.1.3 Crude Distillation

Crude Oil distillation is performed in the atmospheric distillation column 100-C101, which separates oil cuts, by simple distillation, based on the difference in boiling temperatures of the components. Partially vaporized crude feed enters the tower, in the flash zone, on tray 33.

This tower has 36 trays divided in two diameter sections: the first one from tray 1 to 14 with an internal diameter of 1600 mm, and the second one from tray 14 to 36 with a diameter of 2000 mm. The tower operates in a pressure range of 1.15 (top) to 1.4 (bottom) barg, and in a temperature range of 160-165º (top) to 300-330º C (bottom).

The 100-C101 can be divided into three sections:

- Overhead section
- Atmospheric Gasoil section
- Residue section

4.2.1.4 Overhead Section

The top vapours which leave the column goes in the heat exchanger 100-E101 A/B, where they are partially condensed and then finally cooled to 70º C in the water cooler 100-E102. Before entering the exchanger 100-E101 A/B, corrosion inhibitor is injected in the vapour pipeline. The liquid and uncondensed vapours are collected in the reflux vessel 100-V101, which is a three-phase separator: vapours and two phases of liquid, white spirit and water. Decanted water is collected in dome's vessel, from where it is drained to sewage.

White spirit from the vessel 100-V101 is sent by pump 100-P102 A/B, to the top of the column as a reflux, to maintain the column's overhead temperature. The excess is sent to 100-E109, where it is cooled to 35oC, before sending to tank farm. Corrosion inhibitor is injected in the reflux stream, before entering into the column.

The corrosion inhibitor provides excellent carbon steel resistance to acid attack from H2S, HCl, CO2, organic acid, SOX acids and HCN.

The flow rate of product is controlled by flow control loop FIC 100-129 cascaded by LIC 100-122. The reflux flow rate controlled by flow control loop FIC 100-331 cascaded by TIC 100-302.

The top reflux stream is used to control the tower overhead temperature by removing heat from vapours. In the same time, it generates internal liquid flow at the top of the column necessary for proper operation of distillation process.

If the top temperature is modifying, TIC 100-302 adjust it through FIC 100-331, using FV 100-331 control valve as follows: an increase of temperature will determine the open of FV 100-331 so more liquid is sent as a reflux and less as a product; else, if the temperature decreases FIC 100-331 acts on FV 100-331, closing it, so the result will be less liquid as a reflux to the column and more as a product.

4.2.1.5 Atmospheric Gasoil Section

From tray 15, atmospheric gasoil (AGO) is drawn off as side product. Also, liquid is pumped around to tray 14, after has been used to recover heat in crude oil preheat train. Pump 100-P104 A/B, routes the liquid to 100-E104. In order to ensure that the separation efficiency in the atmospheric column is good, the amount of heat removed in the exchanger 100-E104 is adjusted by the controller FIC 100-335, using FV 100-335 control valve, which adjust the flow through the exchanger. Then, the atmospheric gasoil is sent back to the 100-C101 at tray 14.

The objective of AGO pump around is to remove heat from 100-C101, which influences the quality of the side products, through column's temperature profile alteration. In normal operation the flow through the pump around circuit remains constant and the heat duty is controlled by passing more or less flow around the heat exchangers. The atmospheric gasoil (product) is taken from the column to the side stripper.

100-C104, where the light components are removed from the gasoil and sent back to the column, on tray 14. This side stripper consists of a packing section of Raschig rings. At the bottom of the column stripping steam is injected. Stripped atmospheric gasoil from the bottom of the side stripper is pumped with 100-P105 A/B to the preheat train, to the heat exchanger 100-E105 to recover the heat and afterward to water cooler 100-E116, in order to reach the temperature of 40° C, required for storage. The flow of the product is controlled through the control loop FIC 100-333.

4.2.1.6 Residue Section

The atmospheric residue, is removed from the column and sent to the vacuum heater, 100-H2, by the pump 100-P106 A/B. The level at the bottom of the column should be kept at a fixed value and for this purpose a control loop, FIC 100-332 cascaded by LIC 100-312, is provided. If the liquid level in the bottom of the column increases, the controller LIC 100-312 sends a signal to FIC 100-332 which acts on valve FV 100-332, opening it. If the liquid level in the bottom of the column decreases, the controller LIC 100-312 send a signal to FIC 100-332 which acts on valve FV 100-332, closing it.

In the same time, controller FIC 100-332 is cascaded by TIC 100-417, which is the one of the two controllers of the outlet temperature from furnace 100-H2. If the outlet temperature of the vacuum heater is higher than of the set point, FIC 100-332 acts the valve FV 100-332, opening it. If the outlet temperature of the vacuum heater is lower than of the set point, FIC 100-332 acts the valve FV 100-332, closing it.

To remove any light component, that would be otherwise taken out in the residue stream, striping steam is continuously injected in the bottom of the tower, under flow control FIC 100-311, which acts on the valve FV 100-311, closing it, or opening it, depending on the required crude/steam ratio.

4.3. Vacuum Distillation Unit

4.3.1. Atmospheric Residue Heater

Atmospheric residue with a temperature of about 305º C, is routed by the pump 100-P106 A/B to the heater 100-H2 to raise the temperature up to about 395º C, the optimum temperature for vacuum column operation. The fuel used is a liquid one (vacuum residue).

The control objectives of the heater's Combustion Control are:

- To supply fuel according to heat demand (heater outlet temperature).
- Maintain sufficient excess air to ensure complete combustion and safe operating conditions.
- Optimize excess of air to maximize fuel efficiency.

The control scheme has been designed such that when an increase in duty is required the air flow rate is increased before the fuel gas flow rate is increased. In addition, when a decrease in heater duty is required the fuel gas is reduced prior to the air flow rate being reduced (cross-limited arrangement). In this way a sufficient amount of combustion air is guaranteed at all times during operation.

Heater's outlet temperature is controlled by adjusting the flow of liquid fuel to the burners, which is accomplished by TIC 100-416, using TCV2 control valve. The signal from TIC 100-416 acts on TCV2, opening it, if the heater's outlet temperature is lower than the set point, else, if the temperature is higher, closing it.

4.3.2. Vacuum Fractionator

Vacuum distillation is performed in the column 100-C102, which aims to separate the cuts with boiling temperature over 270º C. These cannot be separated in the atmospheric column because of high temperatures required, over 500º C. At this temperature the cracking/coking reactions would lead to coke deposits in the technological equipment. To avoid these problems, separation/distillation of these fractions is performed in a vacuum column and so the boiling temperature of fractions falls below 400º C. The column is connected to a vacuum system.

In order to avoid the possible cracking/condensation reactions in the column, the column's bottom diameter is smaller than the rest of the column, which determines a higher speed of the fluid in this section and a lower residence time. The temperature at the bottom of the column is about 355º C, less than the one in the flash zone which is 387º C.

Stripping steam is continuously injected in the bottom of the vacuum column, under flow control, by controller FIC 100-520, using FV 100-520 control valve. The signal sent from FIC 100-520 will open or close the valve, depending on the required atmospheric residue/steam ratio. Its target is to decrease the partial pressure of hydrocarbons and thus to reduce coking and cracking reactions and for stripping any light component that would be otherwise taken out in the residue stream.

The atmospheric residue is fed in the flash zone of the column, on tray 10. The tower operates in a pressure range of 30 (top) to 100 (bottom) mmHg and in a temperature range of 55-57º (top) to 290-295º C (bottom). The column has 13 trays and it can be divided in three sections:

- Vacuum Gasoil section
- Transformer Distillate section
- Residue section

The top vapours which leave the column are condensed in water cooler 100-E108. The two phases are then separated in vessel 100-V102. Non-condensable gases which leave the top of the vessel are absorbed by the vacuum pump 100-P112 A/B and removed from the system. The pump is a liquid ring type placed at the end of the exhaust system, used to produce vacuum of approximately 30 mmHg at the top of the column 100-C102. This solution was adopted, instead of classical system of ejectors/barometric condensers, because it is cheaper, in respect to the plant capacity. Condensed water is removed from the vessel 100-V102 with pump 100-P114 A/B and sent to refinery's sewage.

4.3.2.1 Vacuum Gasoil Section

Vacuum gasoil (VGO) is removed from tray 3, in intermediate vessel 100-V116 under level control by LIC 100-514. From this vessel the pump 100-P109 A/B routes vacuum gasoil to water cooler 100-E112 to reach the temperature of 40º C. A part of VGO is sent as a reflux at the top of the vacuum column, in order to maintain the column's overhead temperature and the rest is sent to tank farm.

In order to ensure that the separation efficiency in the vacuum column is good the temperature at the top of the column is adjusted by TIC 100-501 through FIC 100-505, using FV 100-335. This control valve adjusts the flow rate of VGO to the column. If the top temperature is higher than the set point FIC 100-505 acts the valve FV 100-335, opening it, otherwise closing it.

The excess of liquid drawn off is sent to tank farm as a VGO product. The flow of the product is controlled by FIC 100-637, acting on control valve FV 100-637.

4.3.2.2 Transformer Distillate Section

Transformer Distillate may be drawn from trays 6, 7 or 8 of the column into the intermediate vessel 100-V115. The flow rate drawn is controlled by LIC 100-537 which acts on the valve LV 100-537. From this vessel the liquid is pumped with 100-P110 A/B and sent to the crude oil preheat train, to recover heat in heat exchanger 100-E103. Then it is finally cooled in water cooler 100-E106 to 90oC, the required temperature for storage.

4.3.2.3 Vacuum Residue Section

From the bottom of the column vacuum residue is drawn both, as a product and for pump around. Both are used for preheating the crude oil. Vacuum residue pump around, 100-P107 A/B routes part of the residue to the preheat train, to the exchanger 100-E117 and then back to the column. The other part of vacuum residue is pumped with pump 100-P108 A/B to the preheat train, to the heat exchanger 100-E118, to recover the heat and afterward to water cooler 100-E114, in order to reach the temperature of 110oC, temperature required for storage.

In order to maintain the liquid level in the bottom of the column at a required value, liquid controller LIC 100-523 is used. It receives the value of the liquid level from the transmitter LT 100-523 and compares it with the set point. LIC 100-523 cascades the flow controller FIC 100-538 which acts on control valve FV 100-538 modifying the flow rate of the product as follows: if the level in the bottom of the column decreases, FIC 100-538 acts on FV 100-538, closing it, otherwise, if level increases, FIC 100-538 acts on FV 100-538 opening it.

The flow of residue pumped around through 100-E117 is also controlled and kept at the required value, through FIC 100-545, using FV 100-545 in order to ensure that the separation efficiency in vacuum column is good.

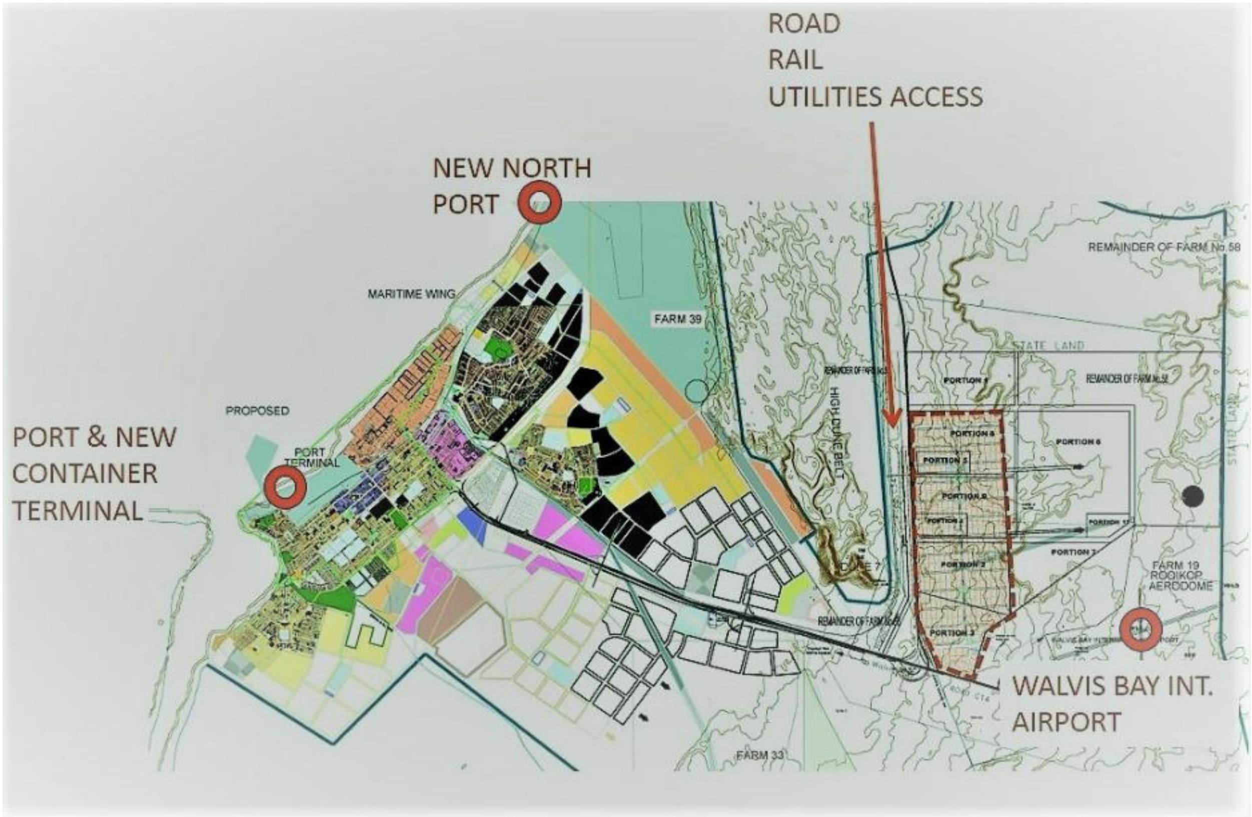

Figure 9: Relative location of the development

4.2. Decision Factors

The following factors served as informants and were considered when preparing the layout designs for the proposed development:

- Walvis Bay Town Planning Scheme.
- Character of the general area.
- Comparative advantage and strategic value of Walvis Bay as an investment location.

4.3. No – Go Alternative

The no-go alternative would essentially entail maintaining the current situation, whereby the country is not utilising the comparative advantages offered by Walvis Bay as an investment destination of choice. The opportunities to augment the country's downstream sector in the oil and gas space will be lost to other countries on the continent and beyond, and perpetuate the over reliance of Namibia from external suppliers. In addition, no operational jobs that come with the envisaged project will be created.

5. PUBLIC PARTICIPATION PROCESS

5.1. Public Consultation Process Phase 1

In terms of Section 21 of the EIA Regulations a call for public consultation with all I&APs during the EIA process is required. This entails consultation with members of the public and providing them an opportunity to comment on the proposed project. The Public Consultation Process does not only incorporate the requirements of Namibia's legislation, but also takes account of national and international best practises. Please see **Table 4** below for the activities undertaken as part of the public participation process.

Table 4: Table of Public Consultation Activities

ACTIVITY	REMARKS
Placement of site notices/posters in Walvis Bay	See **Annexure A**
Placing advertisements in two newspapers for two consecutive weeks, namely Windhoek Observer and Namib Times	See **Annexure B**
Written notice to Interested and Affected Parties via Email	See **Annexure D**
Public meeting in Walvis Bay	12/08/2022

The comment period of the initial public participation process commenced on **29 July 2022** and ended on **19 August 2022.**

5.2. Public Consultation Process Phase 2

The second phase of the Public Consultation Process involved the lodging of the Draft Environmental Scoping Report (DESR) to all registered I&APs for comment on **05 January 2023**. Registered and potential I&APs were informed of the availability of the DESR for public comment. An Executive Summary of the DESR was included in the communication that went out to the registered I&APs. I&APs were given time until **20 January 2023** to submit comments or raise any issues or concerns they may have with regard to the proposed project.

6. ASSSESSMENT METHODOLGY

Impact assessments depend on the nature and magnitude of the proposed activity, as well as the type of environmental control envisaged for the particular project. Given the nature of the proposed activity, i.e., a construction project, the identification and assessment of the potential impacts will be based on the type and scale of the various activities associated with the project.

Assessment of the predicted significance of impacts for a proposed development is by its nature, inherently uncertain. To deal with such uncertainty in a uniform manner, standardised and internationally recognised methodologies have been developed. One such accepted methodology is applied in this study to assess the significance of the potential environmental impacts of the proposed development, outlined as follows in **Table 5**.

Table 5: Impact Assessment Criteria

CRITERIA	CATEGORY
Impact	Description of the expected impact
Nature Describe type of effect	**Positive**: The activity will have a social / economical / environmental benefit. **Neutral**: The activity will have no effect **Negative**: The activity will have a social / economical / environmental harmful effect
Extent Describe the scale of the impact	**Site Specific:** Expanding only as far as the activity itself (onsite) **Small:** restricted to the site's immediate environment within 1 km of the site (limited) **Medium:** Within 5 km of the site (local) **Large:** Beyond 5 km of the site (regional)
Duration Predicts the lifetime of the impact.	**Temporary:** < 1 year (not including construction) **Short-term:** 1 – 5 years **Medium term:** 5 – 15 years **Long-term:** >15 years (Impact will stop after the operational or running life of the activity, either due to natural course or by human interference) **Permanent:** Impact will be where mitigation or moderation by natural course or by human interference will not occur in a particular means or in a particular time period that the impact can be considered temporary
Intensity Describe the magnitude (scale/size) of the Impact	**Zero:** Social and/or natural functions and/ or processes remain unaltered **Very low:** Affects the environment in such a way that natural and/or social functions/processes are not affected **Low:** Natural and/or social functions/processes are slightly altered **Medium:** Natural and/or social functions/processes are notably altered in a modified way **High:** Natural and/or social functions/processes are severely altered and may temporarily or permanently cease
Probability of occurrence Describe the probability of the Impact <u>actually</u> occurring	**Improbable:** Not at all likely **Probable:** Distinctive possibility **Highly probable:** Most likely to happen **Definite:** Impact will occur regardless of any prevention measures
Degree of Confidence in predictions State the degree of confidence in predictions based on availability of information and specialist knowledge	**Unsure/Low:** Little confidence regarding information available (<40%) **Probable/Med:** Moderate confidence regarding information available (40-80%) **Definite/High:** Great confidence regarding information available (>80%)
Significance Rating The impact on each component is determined by a	**Neutral:** A potential concern which was found to have no impact when evaluated

CRITERIA	CATEGORY
combination of the above criteria.	**Very low:** Impacts will be site specific and temporary with no mitigation necessary. **Low:** The impacts will have a minor influence on the proposed development and/or environment. These impacts require some thought to adjustment of the project design where achievable, or alternative mitigation measures **Medium:** Impacts will be experienced in the local and surrounding areas for the life span of the development and may result in long term changes. The impact can be lessened or improved by an amendment in the project design or implementation of effective mitigation measures. **High:** Impacts have a high magnitude and will be experienced regionally for at least the life span of the development, or will be irreversible. The impacts could have the no-go proposition on portions of the development in spite of any mitigation measures that could be implemented.

*NOTE: Where applicable, the magnitude of the impact has to be related to the relevant standard (threshold value specified and source referenced). The magnitude of impact is based on specialist knowledge of that particular field.

For each impact, the EXTENT (spatial scale), MAGNITUDE (size or degree scale) and DURATION (time scale) are described. These criteria are used to ascertain the SIGNIFICANCE of the impact, firstly in the case of no mitigation and then with the most effective mitigation measure(s) in place. The decision as to which combination of alternatives and mitigation measures to apply lies with the proponent, and their acceptance and approval ultimately with the relevant environmental authority.

The SIGNIFICANCE of an impact is derived by taking into account the temporal and spatial scales and magnitude. Such significance is also informed by the context of the impact, i.e. the character and identity of the receptor of the impact.

7. MITIGATION HIERACHY

The mitigation hierarchy is a tool aimed at helping to manage biodiversity risk, and is commonly applied in Environmental Impact Assessments. The most common reference point for banks providing project finance is mitigation measures; this provides the financial institutions with information on how environmental and social risks will be managed (See **Figure 10** below). These cover avoidance, minimization, restoration and compensation amongst other things. It is possible and considered sought after to enhance the environment by ensuring that positive gains are included in the proposed activity or project. If negative impacts occur, then the hierarchy indicates further steps.

Figure 10: Mitigation Hierarchy

Impact avoidance: This step is most effective when applied at an early stage of project planning. It can be achieved by:

- not undertaking certain projects or elements that could result in adverse impacts;
- avoiding areas that are environmentally sensitive; and
- putting in place preventative measures to stop adverse impacts from occurring.

Impact minimization: This step is usually taken during impact identification and prediction to limit or reduce the degree, extent, magnitude, or duration of adverse impacts. It can be achieved by:

- scaling down or relocating the proposal;
- redesigning elements of the project; and
- taking supplementary measures to manage the impacts

Restoration: This step is taken to improve degraded or removed ecosystems following exposure to impacts that cannot be completely avoided or minimised. Restoration tries to return an area to the original ecosystem that occurred before impacts. Restoration is frequently needed towards the end of a project's life-cycle, but may be possible in some areas during operation.

Impact compensation: This step is usually applied to remedy unavoidable residual adverse impacts. It can be achieved by:

- rehabilitation of the affected site or environment, for example, by habitat enhancement;
- restoration of the affected site or environment to its previous state or better; and
- replacement of the same resource values at another location (off-set), for example, by wetland engineering to provide an equivalent area to that lost to drainage or infill. Offsets are often complex and expensive; it is therefore preferable to pay attention to earlier steps in the mitigation hierarchy.

8. POTENTIAL IMPACTS

This Chapter describes the potential impacts on the biophysical and socio-economic environments, which may occur due to the proposed activities. These include potential impacts, which may arise during the planning and design phase, potential construction related impacts (i.e., short to medium term) as well as the operational impacts of the proposed development (i.e., long-term impacts).

The assessment of potential impacts will help to inform and confirm the selection of the preferred project plan and design to be submitted to MEFT: DEA for consideration. In turn, MEFT: DEA's decision on the environmental acceptability of the proposed project and the setting of conditions of authorisation (should the project be authorised) will be informed by this chapter, amongst other information contained in this Report.

The baseline and potential impacts that could result from the proposed development are described and assessed with mitigation measures recommended. Finally, comment is provided on the potential cumulative impacts which could result should this development, and others like it in the area, be approved.

Distillation, absorption and adsorption, chemical reaction, extraction with solvents, and so forth are the unit operations that make up a refinery operation. They consume a huge amount of water, energy, catalysts, and chemicals.

As a result, the following environmental issues may be expected. Atmospheric emissions may be expected mainly because of combustion products (in terms of the greatest mass of emissions) but also because of the storage tank farm and the sulfur recovery plant. Wastewater may be expected because of the number of processes in a refinery requiring large volumes of water. Additionally, solid wastes may be expected because of off-specification process streams, spent catalysts, and spent caustics.

Because of the many pollution sources in petroleum refineries, it is necessary to determine the most important ones (Rodríguez& Matinez, 2005)

Atmospheric Emissions

Petroleum refineries are important generators of the following pollutants: SO_2, NOx (NO and NO_2), VOC, CO, and to a lesser extent NH_3, H_2S and particulates. Sources for these pollutants are listed below:

Combustion Processes

The pollutants generated in combustion processes represent 80% of the total main pollutants (SO_2, NOx, and particulates) and are present in most unit operations. It is worth noting that a medium to high conversion refinery spends 9% of the crude fed to the complex as fuel for combustion processes.

Fluid Catalytic Cracking Unit (FCCU)

This unit converts heavy gas-oil into more valuable products (LPG, gasoline, and light gas-oil); it is an important source of SO_2, NOx, and particulate emissions.

Storage of Feedstocks and Products

Storage of feedstocks and products are thought to be one of the most important sources of VOC emissions in the refinery.

Liquid Effluents

Main contributors of liquid effluents are as follows.

Crude Desalter

Crude composition includes inorganic salts that need to be removed before processing. To attain this objective, crude is washed with fresh water before crude atmospheric distillation. The resulting aqueous effluent has high organic (because of oil entrainment) and inorganic loads.

FCCU and Hydrotreating Processes

The process of making up water to prevent inorganic salt formation in heat exchangers produces liquid effluent with high levels of $SO_2$and NH_3.

Utilities Systems.

Every refinery, as any other chemical industrial complex, has a network of utilities. Among them, the cooling water and boiler feed water systems need a blowdown stream, which contains a high level of solids and chemicals.

Solid Wastes

Solid wastes that should be taken into account as part of total waste generation are as follows.

Process Purges

Different process units throughout the refinery produce streams that are out of specification (because of process malfunction or maintenance reasons), which need to be managed either internally or off-site.

Catalytic Units

Many of the process units need to be operated with catalyst support. This requires spent catalyst to be properly managed.

Caustic Treating Processes

Sulfur species with corrosive properties need to be removed using caustic solutions (10% wt concentration typical) to produce commercial products (LPG and light gasoline). Spent caustic streams need to be managed to reduce their high chemical oxygen demand (COD).

8.1. Planning and Design Phase Impacts

During the planning and design phase consideration is given to aspects such as surface and groundwater; fauna and flora; existing infrastructure; and traffic. Note should be taken that the planning and design phase impacts are applicable during the operational phase as well.

8.1.1. Surface and Groundwater

The proposed development site is located approximately 18 km from the shoreline of the Atlantic Ocean, this puts the surface and ground water resources in the area at risk of pollution. This is likely to happen in the absence of well designed and constructed storm water drainage infrastructure. Poorly constructed and maintained service infrastructure in general may also, for example, lead to seepage of waste water into the water bodies. Surface and ground water contamination may result from nonpoint source runoff from nearby activities; urban runoff conveyed to the sea by storm sewer system; and occurrences of bank erosion (Sosiak and Dixon, 2006). Uncontrolled solid waste management is another potential pollutant of the surface water.

8.1.2. Fauna and Flora

The general area is sparsely populated with flora, and not much vegetation visible. The existing vegetation in the general area is more characteristic and typical of a coastal environment, but the proposed area is open with no vegetation visible. The proposed development areas and associated infrastructure would be relatively small and thus only have localised negative implications on the environment and associated fauna and flora. The overall impact on the local fauna and flora and associated habitat would be relatively small. While no obvious large animals could be observed on the development site, it could be expected that the area may also support species of smaller vertebrates such as reptiles, amphibians, mammals and birds.

8.1.3. Existing Service Infrastructure

There is a consideration to extend bulk water services to the site from the existing Namwater pipeline found in the development area, although technical details have to be discussed with Namwater and the proponent's design team as there appear to be challenges with water pressure from the pipeline. The proponent intends to construct a new waste water treatment plant to manage sewer and waste water generated from the activities of the development. The municipality also has long-term plans to provide waste water facilities in the area, it is therefore advisable that the developer engages the Municipality to discuss options for cost sharing.

Electricity will be provided to the site in consultation with the regional electricity distributor, ErongoRED. Access will initially be obtained from the road towards the Walvis Bay International Airport in the short term. A rail and road servitude has been provided for along the northern border of Portion 3 of Farm 58, as well as another one further north along Portion 8 of Farm 58. These will make it possible for long term access to this and other developments in Farm 58.

8.1.4. Firewater Supply

The proposed site for the refinery is approximately 12 km from the Walvis Bay Fire station and about 4 km from the Walvis Bay Airport. There are no fire-threatening activities within the proposed site. However, this may change in the future.

The final products of a petroleum refinery are quite hazardous because of their highly flammable nature. Fire risks encountered in an oil refinery include flammable liquids and explosive materials. A small mistake could cause massive damage to life, property, pollution, injury, ecosystem, and business by fire. Therefore, fire risk assessment and forecasting are necessary during the design phase to anticipate how to overcome personal, environmental, and refinery plants' hazard situations.

A visit and discussion with the Walvis Bay fire station head office reveal the following:

- The fire station has been servicing hydrocarbon storage facilities within Walvis Bay,
- The station is equipped with two fire trucks with for water and foam,
- There are about personnel and volunteers who are always on standby for any emergencies 24/7,
- The fire unit, however, has not had any experience in petrochemical fires of an industrial scale.

Following the above, and because the refinery will be located out of the Walvis Bay town, it is recommended as follows:

1. A recognised professional and persons with experience in the oil and gas sector should develop a comprehensive life and fire safety philosophy.
2. The life and fire safety design philosophy should consider that third-party intervention in an emergency is not guaranteed.

It is further recommended that the following aspects be considered for inclusion in the above, based on best practise:

Two independent firewater supply systems are planned for indoor and outdoor fire suppression at the Oil Refinery.

- Firewater supply system for the facilities of the Oil Refinery (Stage 1);
- Firewater supply system for the facilities of the deep conversion plant (to be developed during Stage 2).

The firewater supply system for the Oil Refinery includes a pump station, storage tanks for a firewater reserve, firewater ponds of 250 m^3 capacity each, and a firewater pipeline of ring-shaped design. The overall firewater reserve Oil Refinery will be computed to ensure water for suppression of two fires at the same time (one in the production zone and another one in a tank farm for inflammable gases and liquids). The maximum water requirement for simultaneous suppression of two fires shall be 1575 l/sec or 5671 m^3/hour. The minimum required firewater reserve will have a capacity of approximately 13,000 m^3, based on the requirement for simultaneous suppression of two fires.

For the firewater reserve storage, there will be two storage tanks of 10,000 m^3capacity each. The storage tanks will be equipped with devices for automatic replenishment of the water reserve if the water in the tanks lowers below a certain level. The time needed to restore the required firewater reserve after fire suppression will not exceed 24 hours. The firewater tanks will be filled from the Namwater supply line (Taneco, 2009).

8.1.5. Traffic

There will be movement of traffic during the operational phase of the project. Due to the nature of the development and the land use, vehicles that will frequent the area would mostly consist of vehicles used by the workforce as well as delivery vehicles and clients. This will add additional pressure on the existing D1984 and C14 roads, if not well managed. No direct access to the freeway will be supported by the Roads Authority. The development's boundaries should be positioned at least 45m from the edge of the proclaimed national roads, both trunk and main roads.

8.2. Construction Phase Impacts

During the construction phase the following potential impacts have been identified: fauna and flora; pressure on the existing infrastructure; surface and ground water; health, safety and security impacts; air quality; noise, traffic; solid waste management; hazardous substances; and social impact.

8.2.1. Flora and Fauna

There are no protected or red data listed plants or animal species found on the site however care should be taken that no risk is posed to the adjacent marine ecosystem, including seabirds, that may be found in the area during the construction phase.

8.2.2. Pressure on existing infrastructure

During the construction phase there will be an additional demand for basic municipal services such as water, electricity and sewer. The services will be used for both human consumption and for construction purposes. These impacts will however only be limited to the construction phase and will thus have minimal short-term impact. The risk of wastage and pollution may occur if no proper management actions are implemented.

During the construction phase of the Oil Refinery, water for sanitary and drinking needs on construction site will be supplied from the Namwater pipeline.

- During the construction of the Stage 1 facilities, water will be required for the following purposes
- For sanitary and drinking needs of the construction personnel;
- For industrial needs, including:
    - Dust suppression in the area of earthmoving operations;
    - Washing of vehicles;
    - Hydraulic testing of pipelines / tanks before putting them into operation.

During the construction of the bulk service infrastructure, drinking water would be obtained from the Namwater pipeline. The construction design provides for the supply of drinking water for the needs of the construction personnel.

Wastewater generated during the construction phase will be discharged to septic tanks and then removed to the wastewater works of the Walvis Bay Municipality. Mobile toilets will be installed at the construction site. Sewage will be removed according to the prescribed procedure for treatment. Storm water runoff will be drained from the graded sites.

Water diversion ditches will be provided along roads for storm water runoff drainage from areas free from constructed facilities. Taking into account the organizational and technical measures planned for protection of surface and underground waters during the construction phase, the environmental risks associated with water supply and wastewater removal will be minimal during the construction of the Stage 1 facilities.

8.2.3. Surface and Ground Water Impacts

Surface and ground water impacts may be encountered during the construction phase. The risk of contaminating such water sources can be increased by accidental spillage of oils and fuels and any other equipment used during construction; chemical contamination from construction materials such as cement, paint and mechanical fluids. This risk is minimised by the fact that the construction period will be a short-term activity.

8.2.4. Health, Safety and Security Impacts

Due to a high demand of construction workers during this phase of the project, the deployment of a temporary construction workforce in Walvis Bay may be necessary. These types of projects, where construction workers have the opportunity to interact with the local community, create a significant risk for the development of social conditions and behaviors that contribute to the spread of HIV, AIDS and Covid-19. The Ministry of Environment, Forestry and Tourism has initiated a programme aimed at mainstreaming HIV and gender issues into environmental impact assessments. Safety and security aspects are a critical part of any construction activity and high standards have to be upheld for the duration of the construction period.

8.2.5. Air Quality

During the construction phase fugitive dust and exhaust gases generated have a potential impact on the air quality of the area and its surroundings. Dust is a major component of air pollution and could negatively affect the health of nearby communities if not mitigated. Due to the proximity of the development site to the C14 Main Road as well as to the D1984, traffic on these roads is also at risk of being impacted by dust. These are however short-term impacts.

Dust is generated mainly from the following activities:

- Excavations and stockpiles during site clearance;
- Procurement and transport of construction materials to the site.
- Internal combustion engines of construction machinery;
- Hoisting mechanisms;
- Vehicles transport;
- Welding and drying equipment on construction sites;
- Gas cutting stations;
- Unloading and storage of inert materials (crushed stone, sand);
- Dust from the ground surface disturbed by earthmoving operations

Welding work will emit manganese dioxide and welding aerosol emissions; transport vehicles and construction machinery release exhaust gas consisting of numerous components divided into several groups based on similar impact on environment and human health or qualitatively similar in relation to their chemical structure and properties:

- Non-toxic substances: nitrogen, oxygen, hydrogen, water vapor and carbon dioxide;
- Carbon monoxide, the presence of which in large amounts (up to 12%) is characteristic of exhaust gas from internal combustion engines using gasoline;
- Nitrogen oxides;
- Hydrocarbons, aromatic compounds, including carcinogen;
- Spent gas components: aldehydes (Taneco, 2009).

The project area is a safe distance away from the nearest and planned residential areas and other developments, and dust would therefore not interfere significantly on the community during the short-term construction phase.

8.2.6. Noise Impacts

Noise is perceived as one of the most undesirable consequences of a construction activity. The most common reported impacts are interference in oral communication and sleep disturbance. The construction of the services, and other structures will result in associated noise impacts. These noise impacts will mainly be associated with construction machinery and vehicles, concrete and mixing; and excavation for foundations. It is important that noise is managed well to avoid a negative impact to the surrounding communities and other developments in the vicinity during the short-term construction phase.

8.2.7. Traffic Impacts

Traffic is expected to increase during the construction phase of the project. Trucks and other heavy machinery will be required to deliver, handle and position construction materials as well as to remove spoil material. Not only will the increase in traffic result in associated noise impacts, it will also impact on the vehicular traffic in the area. The use of slow-moving heavy construction trucks has the potential to cause traffic jams. This will add additional pressure on the existing D1984 and C14 roads, if not well managed.

8.2.8. Solid Waste Management

The construction activities will lead to the generation of significant amounts of solid waste mainly in the form of construction building rubble. This could have a negative environmental impact if not managed well. Therefore, enough waste bins and skip containers should be availed to manage the solid waste. All solid waste should be disposed of at the designated landfill site of Walvis Bay as approved by the local authority.

8.2.9. Storage and Utilisation of Hazardous Substances

Hazardous substances are regarded by the Hazardous Substance Ordinance (No. 14 of 1974) as those substances which may cause injury or ill-health to or death of human beings by reason of their toxic, corrosive, irritant, strongly sensitizing or flammable nature or the generation of pressure in certain circumstances. It covers manufacture, sale, use, disposal and dumping as well as import and export. During the construction period, the use and storage of these types of hazardous substances, such as shutter oil, curing compounds, types of solvents, primers and adhesives and diesel, on-site, could have negative impact on the surrounding environment, if these substances spill and enter the environment.

8.2.10. Social Impacts

The project will result in long-term positive impacts as far as the social welfare of the affected community is concerned. There is potential of an influx of migrant workers into the town of Walvis Bay. This would boost the local economic development of the town as a result of an increase in consumers of goods, and spending power. The local community will benefit through preferential recruitment of local labour and procurement as far as possible.

8.3. Operational Phase Impacts

The operational phase impacts that have been identified are: environmental monitoring and evaluation; noise; waste management; social; and visual impact.

8.3.1. Environmental Monitoring and Evaluation

The Environmental Commissioner requires regular environmental monitoring and evaluation on environmental performance to be conducted on approved developments, as well as the setting and monitoring of targets for improvement. As part of this exercise bi-annual reports have to be submitted to the Office of the Environmental Commissioner for the duration of the environmental clearance certificate.

8.3.2. Air Emissions Impacts

The main sources of pollutants emissions in the air from Phase 1 operations will be:

- Technological furnaces, flare facilities, transport vehicles and railroad transport (nitrogen oxides, carbon monoxide and sulfur dioxide);
- Sealing elements of movable and stationary connections of process equipment, pipelines, valves, devices for loading of petroleum products into transport means, surfaces of wastewater treatment facilities, etc. (hydrocarbons);
- Wastewater treatment facilities, water supply systems, process equipment of main production facilities, tank farms and pump stations (hydrogen sulfide).

At the crude oil reception station of the oil pipeline there will be the following air emission sources:

- Equipment of pump stations;
- Scraper receivers and launchers;
- Filters / mud collectors;
- Pressure regulators;
- Safety valve assemblies;
- Oil metering station with pipe-and-piston calibration devices;
- Tanks for petroleum discharge and drainage vessels.

Atmospheric air pollution will be also caused by operating process equipment due to imperfect sealing of shut-off and regulating valves, gaskets and end seals, drainage devices. The following pollutants will be released: saturated hydrocarbons C1-C5, C6-C10, amilenes, benzene, xylene, toluene, hydrogen sulfide, saturated hydrocarbons and mineral oil.

Accidental and one-time releases of pollutants into the atmosphere from flare facilities will take place during emergency shutdown of technological installations requiring emptying of the process equipment and discharge of the gaseous and liquid phases to the flare system and drainage tanks, respectively. Under normal operating conditions, emissions from the flare facilities will be minimal. The flare systems will use flushing gas in stand-by mode (Taneco, 2009).

8.3.3. Noise Impacts

The operational phase could typically generate noise through the amount and frequency of use of the various types of vehicles that will be used for delivery of goods, transportation of workforce, clients, road noise from the vehicles engines and the tyres contact with the road surface as well as noise from the warning devices on the trucks i.e., hooters.

Namibia has no environmental noise and impact guidelines, reference is made to guidelines published by the International Finance Corporation (IFC, 2007) (See **Table 6** below) and the South African Bureau of Standards (SABS) (SANS 10103, 2008). Both these guidelines are in line with the World Health Organisation (WHO) Guidelines for Community Noise (WHO, 1999).

Table 6: Environmental Noise standard

Noise Level Guidelines (IFC, 2007)		
Area	**One Hour LAeq (dBA) 07:00 to 22:0**	**One Hour LAeq (dBA) 22:00 to 07:00**
Industrial receptors	70	70
Residential, institutional and educational receptors	55	45

By applying a series of the mitigation measures as proposed for general developments of this nature it is believed that any potential nuisance can be significantly reduced.

8.3.4. Waste Management

Waste generated is likely to include empty storage containers and packaging, general litter, by-products of any vehicle maintenance (including petroleum products, coolants, degreasing agents, sediment, rubber particles, detergents), and other hazardous materials. All waste should be disposed of in line with the national waste management directives. General and hazardous waste will be removed by the municipality or contractors and sorted at the municipal landfill site or hazardous waste site as necessary. The proponent should manage their waste in close consultation with the Municipality of Walvis Bay, in line with their requirements.

8.3.5. Social Impact

The construction and operation of the refinery will have a positive impact on the socio-economic status of Walvis Bay and its residents. This is due to the job opportunities that will be created both directly related to the refinery operations and indirectly from supporting services; as well as the opportunities for skills development and on-site training. During the construction phase a few temporary jobs will be created but more permanent jobs will be created when operations commence. The establishment of Walvis Bay refinery will have a positive effect on increased port services.

8.3.6. Visual and Sense of Place Impacts

The proposed site which is intended for the development is currently vacant and undeveloped and will now be developed with various infrastructure. Individuals who frequent the area on a regular basis will experience a change in their sense of place of the area. The extent of this disturbance will depend on how high they valued the initial aesthetic quality of the site. Therefore, the aesthetics quality of the new structures has to be pleasing and designed to blend in with the natural surrounds.

9. SUMMARY OF POTENTIAL IMPACTS

A summary of the significance of the potential impacts from the proposed project assessed above is included in **Table 7**. A summary of the mitigation measures proposed for the potential impacts are provided further in this chapter.

Table 7: Summary of potential impacts

Impacts	Negative		Positive		No Impact
	Short Term	Long Term	Short Term	Long Term	
Planning and Design Phase					
1. Surface and ground water	X				
2. Fauna and flora	X				
3. Existing infrastructure	X				
4. Firewater supply		X			
5. Traffic		X			
Construction Phase					
6. Fauna and flora	X				
7. Pressure on existing infrastructure	X				
8. Surface and groundwater	X				
9. Health, safety and security	X				
10. Air quality	X				
11. Noise	X				
12. Traffic	X				
13. Waste management	X				
14. Hazardous substances	X				
15. Social	X				

Operational Phase					
16. Environmental Monitoring and evaluation		X			
17. Air emissions impacts		X			
18. Noise		X			
19. Waste Management		X			
20. Social				X	
21. Visual	X				

9.1. ATMOSPHERIC AIR QUALITY

9.1.1. Construction Phase

During the construction phase, air emission monitoring will be conducted mainly by the construction contractors and subcontractors, who should ensure annual checking of exhaust gas quality from engines of vehicles and machinery to verify their compliance with the local environmental requirements in Namibia and of the international best practise.

Clasox should ensure periodic monitoring of compliance of contractors and subcontractors working on the construction site with the applicable local environmental requirements. To determine the background concentrations of impurities in atmospheric air and confirm the predicted concentrations during the construction phase it will be necessary to conduct background monitoring of atmospheric air within the area affected by the Clasox facilities in conformity with a program of routine environmental monitoring.

Loose bulk materials will be delivered to the construction site by trucks, covered with tarpaulin to prevent release of dust into the air. During unloading of loose materials, they will be sprayed with water to eliminate any dust. Sand and crushed stone will be stored in special areas under shelter and covered with tarpaulin. This means that loose materials will not be a source of atmospheric pollution. To prevent dust transfer from areas of earthmoving operations during warm season, the disturbed soil surface will be sprayed with water on a regular basis. In order to reduce air emissions during the construction phase the following additional measures will be taken:

- Use of open fire to burn any materials or waste will be prohibited;
- Permanent monitoring of technological processes will be conducted to minimize emissions of pollutants;
- No materials and substances emitting toxic and carcinogenic substances will be used for construction;
- Equipment, machinery and transport vehicles used during the construction period will comply with the standards and specifications of manufacturers in relation to exhaust gas emissions approved by the sanitary supervisory agency;
- Minimization of exhaust gas emissions from diesel engines and adjustment of fuel systems will be carried out in due time;
- In the course of technical maintenance of machinery, special attention will be given to the verification and the adjustment of fuel feedstock, ignition and gas distribution systems of engines. This will ensure complete fuel combustion, reduce fuel requirement and decrease significantly exhaust gas emissions;
- Fuel spills will be eliminated in the process of filling the construction machinery. Filling will be carried out in special areas with hard paving and containment bunding.

9.1.2. Operation Phase

The following activities will be conducted by Clasox during Stage 1 operation period with respect to atmospheric air quality monitoring:

- Automatic monitoring at identified emission sources released to the atmosphere;
- Periodic monitoring (at least four times per day at the stationary station and up to 50 measurements of 8 pollutants per year with the aid of a mobile laboratory) with subsequent assessment of the safety level of the impact of emissions from the new facilities on public health;

The monitoring data will permit a review of compliance with the design parameters and demonstrate compliance with the regulatory requirements to atmospheric air quality in the nearest residential and industrial areas affected by the development.

In addition, the following measures are planned to resolve certain issues associated with emission reduction from water supply and wastewater removal facilities:

- Highly efficient water-cooling towers will be used in water recycling systems;
- Oil recovery devices with covered surface will be used;
- Manholes in the industrial sewer networks will be of enclosed type; manholes on the roads will have double lids and the space between the lids will be filled with sand;
- Wastewater treatment facilities will be of enclosed type to a maximum possible degree.

9.2. BEST AVAILABLE TECHNIQUES (BATS)

The petroleum refining industry plays an important role in the developed economies and also has a potential for pollution generation that must be controlled. The best solution for all (i.e., petroleum companies, the public, and the environment) is pollution prevention, because this option will protect all of them and will also reduce costs in terms of lower raw materials consumption as well as reducing potential fines.

European Union efforts resulted in the European Directive 96/61/European Commission, commonly known as the Integrated Pollution Prevention and Control Directive. This policy established the need for stricter environmental control to provide greater protection for the environment. To achieve this goal the directive strongly recommended pollution prevention options rather than traditional approaches, such as pollutant treatment. This policy required nearly all industrial operators to hold an environmental operating permit based on Best Available Techniques (BATs). Developing countries in general and Clasox in particular will do well to learn from these experiences, key BATs are delineated below (Rodríguez& Matinez, 2005).

9.2.1. BATs FOR MINIMIZATION OF NOX EMISSIONS FROM COMBUSTION PROCESSES

9.2.1.1. Low NOx Burners

Nowadays industries install low NO_x burners to reduce thermal NO_x generation by achieving lower flame temperatures. The main types of technologies being used involve either air or fuel staged addition. Some gas burners incorporate flue gas recirculation as an alternative to reduce flame temperature.

Selective Catalytic Reduction.

This is a proven technology that favours the reaction of combustion gases (including NO_x) with added NH_3 (supported by V_2O_5/TiO_2 catalyst). The presence of a catalyst enhances the reaction, lowering operating temperatures down to a range between 315 °C and 400 °C.

Use of Gaseous Fuels.

Substitution of conventional liquid (nitrogen-containing) fuels with gaseous fuel (nearly nitrogen-free) significantly reduces NO_x emissions; natural gas produces 159 mg/Nm^3 versus fuel oil production of 350 mg/Nm^3. In addition, there is a significant reduction in other atmospheric pollutants such as SO_2 (natural gas can be assumed to have a negligible sulfur content), particulate, and CO/CO_2.

To include this BAT in an industry is not always a straightforward task. It requires the full involvement of a planning team, and it is necessary to make an individualized economic assessment. Key issues for consideration during this analysis are the following: (1) the need to burn fuel gas produced throughout the refinery, and (2) the need to burn residual liquid fuels that do not comply with commercial specifications. Twenty-first century refineries need to minimize heavy fuel production, especially residual fuels mentioned in the previous point. Moving away from heavier fuels reduces the amount of waste disposal required. There is a downside, however; often the cleaner fuels are more costly to use than the heavier fuels that would be readily available at a petroleum refinery.

Energy Integration.

Several energy integration techniques, such as Pinch Technology, help refiners to optimize their fuel consumption and, consequently, their atmospheric emissions. A typical application is a heat exchanger network or integration of a reboiler and condenser into the same heat exchanger. An energy integration plan for a 700 m^3/hr crude distillation unit can produce an annual financial saving of U.S.$700,000 because of the 684 kg/hr of non-burnt fuel (5470 mT/yr with an on-stream operating factor of 8000 hr/yr). This energy integration plan also produces an important reduction in atmospheric pollutants: (1) SO_2: 14.5 kg/hr, considering that sulfur fuel oil content is 2% wt, (2) NO_x: 4.2 kg/hr, (3) CO2: 2134 kg/hr, and (4) particulate matter: 0.9 kg/hr (Rodríguez& Matinez, 2005).

9.2.2. BATs TO REDUCE LIQUID EFFLUENTS

The proposed BATs to be analyzed are the following: (1) integration of different water consuming processes, (2) liquid stream segregation, and (3) reverse osmosis units.

Integration of Different Water Consuming Processes.

There are two objectives of water integration: a reduction in the net amount of water consumed and a reduction in the total loading of pollutants that must be treated in WWTPs (wastewater treatment plants) for final discharge. These objectives can be accomplished by process water, storm water, and cooling water recycling and reutilization, in a two-stage process: (1) water mass balance throughout the refinery and for each process unit, and (2) setting min water feed quality requirements (max values for some pollutants) for each unit and effluent composition analysis. After completing these two stages to establish the vol and loadings to and from each unit, pollution prevention options applicable to those streams (individually or combined) can be developed.

After determining which option(s) will be pursued, objectives can be established, measured, and progress toward the goal/objective monitored. Previous studies on water conservation discussed several options for water consumption optimization and calculated the cost and efficiency of wastewater reduction.

Some of the limitations for water conservation studies are the following: (1) corrosion phenomena, (2) fouling and sedimentation, (3) loss of mass transfer in washing process using water, and (4) WWTP location in relation to the point of use because of the pumping cost. This can represent an unaffordable financial cost for the refinery.

Liquid Stream Segregation.

Water consumption optimization can be enhanced with proper stream segregation based on the nature or composition of those streams. An indiscriminate mixture of heavily contaminated aqueous streams with other lightly contaminated streams should be avoided, because any potential for reuse would probably be lost. Advantages of this selective segregation are as follows: (1) lower amount of water to be treated as wastewater, (2) selection of the most appropriate treatment for each stream avoiding unnecessary streams and avoiding dilution of other streams that would increase the difficulty of treatment, and (3) lower initial investment required as well as less operating costs for both water conditioning and water treatment. Rational stream management is based on stream characterization, and classification is as follows: (1) oil free contamination streams, for example, steam condensate from heat exchangers; (2) accidentally oil contaminated streams, for example, storm water collected from process areas; and (3) continuously oil contaminated streams. They can be divided into high organic load streams (wastewater from tank area and crude desalters) and low organic load ones.

Reverse Osmosis (RO) Units.

RO units are a real option to improve water consumption in particular cases. Costs have been significantly reduced, and analysis of each case can show positive financial benefits. Typical applications of this are boiler feed water conditioning processes and water quality improvement of WWTP effluent, because it can be considered as a potential feed for the cooling water circuit. Advantages associated with the use of ROs are easy to evaluate and include a 90% efficiency rate in water pollutants removal, a lower risk of deposits in water coolers, lower sludge generation because of higher quality water, and a reduction in associated treatment. The main disadvantages are the high level of investment required for this and the importance of influent quality (pre-treatment usually required) (Rodríguez& Matinez, 2005).

9.2.3. BATs FOR WASTE MINIMIZATION

The proposed BATs for waste minimization are described. Oily sludge BATs include the following: (1) integrated sludge management system, (2) tank bottoms minimization, and (3) oily sludge destruction in coking units without pre-treatment. Spent caustics BATs include the following: (1) segregation and cascade reuse, and (2) wet air oxidation units.

Integrated Sludge Management System.

This scheme has been selected as a candidate to be a BAT for the following reasons: (1) the reduction of solid build-up which otherwise tend to increase sludge generation, and (2) the improvement of oil recovery and its posterior recycling to process units.

Tank Bottom Minimization.

Minimization of generation of tank bottoms (heavy components that decant during storage time) can be achieved using dedicated emulsifying chemicals. An average composition of sludge tank bottoms may consist of the following: hydrocarbons 40– 90%, water 10–50%, and solids 2–50%. Emulsifiers can help to produce a homogeneous composition in the tank avoiding bottom generation. The main disadvantage is that entrainment emulsifiers can disrupt crude desalter operation. This is the reason why its usage must be carefully analysed in each particular case. Other options are available, such as tank design or programmed throughput, but these do not offer the same advantages as emulsifiers in terms of time of implementation and operational flexibility.

Oily Sludge Destruction in Coking Units Without Pre-treatment.

Refineries with coking units in their process scheme can use these to destroy the following oily streams without the need for pre-treatment: (1) American Petroleum Institute separator sludge, (2) dissolved air flotation unit sludge, (3) oily residual streams, and (4) sludge from heat exchanger cleaning process.

This operation allows hydrocarbon recovery, whereas solids get trapped inside the coke. The amount of sludge that can be destroyed is controlled by several factors: (1) coke quality: metals, ash, and VOC limit the quality required for commercial sale; (2) 1 kg of sludge per mT of coke production; and (c) max unit capacity: feeding these sludges reduces fresh feed rate.

The main advantages of these BATs are the ability to destroy hazardous wastes without any pre-treatment and the cost reduction arising from waste management processes no longer required. The main disadvantages are that this BAT entails a lower level of energy efficiency, a reduced coke quality, and a reduction in distillate production depending on the coke feeding system. Another point to take into account is the cost and efficiency of the process versus the disposal and beneficial use of a material that would otherwise be handled as a waste. This is a balance that must be assessed and managed in the light of both economic and process considerations.

Spent Caustics Segregation and Cascade Reuse.

The petroleum refining industry removes sulfur acid compounds from petroleum distillates using caustic solutions. Those impurities are mainly H_2S and mercaptanes. Unfortunately, this kind of chemical treatment generates a significant number of spent caustics.

These wastes cannot be massively fed to Waste Water Treatment Plants (WWTP) because of their COD values, mainly caused by compounds such as Na_2S, sodium mercaptides, and thiols. Proper segregation of spent caustics permits their efficient management. The criterion for this segregation is the nature of the pollutants (naphtenic, sulfidic, and phenolic) removed during neutralization processes. As a consequence of this segregation, the spent caustics may be reused in a cascade: spent caustic and distillate streams are mixed cross-currently to improve mass transfer of the pollutants; the spent caustic for one process unit can be reused in other processes that are less demanding in terms of the quality of the caustic. As a result, caustic consumption significantly decreases.

Wet Air Oxidation Units for Spent Caustics.

Oxidation of spent caustics with wet air at high pressure and temperature conditions allows refineries to send these caustics to WWTPs because of the COD reduction with values up to 80% and a nearly total destruction of phenols and other heavy sulfur compounds. Typical operating conditions are 270 °C and 100 kN/m2.

The main disadvantages, when comparing this with conventional process units, are the high level of investment required and the high operating costs. The degree of investment results from the equipment design conditions (design temperature and pressure, as well as metallurgy), which become necessary on account of the severe operating conditions in terms of pressure, temperature, and corrosive chemical species. High operating costs are incurred on account of the consumption of utilities, mainly high-pressure steam and electricity (Rodríguez& Matinez, 2005).

10. DECOMMISSIONING

It is not envisaged to decommission the development in the immediate future. However, should this be considered at the end of its useful life, the area has to be restored to *ante operam* conditions. It is recommended that a decommissioning plan should be developed within the first 24 months of operation.

11. CONCLUSION AND RECOMMENDATIONS

11.1. Construction Phase Impacts

With reference to **Table 9**, most of the construction phase impacts were deemed to have a negative impact without mitigation. However, these were mostly short-term and can be significantly reduced with the mitigation measures proposed.

11.2. Planning and Design Phase

During the planning and design phase the impacts of traffic were assessed to have a long-term negative effect without mitigation, while the impacts of surface and groundwater; fauna and flora, and existing infrastructure were assessed to have short-term negative effect. The impacts will however be significantly reduced when the recommended mitigation measures in the scoping report and environmental management plan (EMP) are implemented.

The impacts on the and social aspect are deemed to be high positive. This development is not only important to provide services to the end-users, but it also promotes local economic development.

11.3. Level of Confidence in Assessment

With reference to the information available at this stage, the confidence in the environmental assessment undertaken is regarded as being acceptable for decision-making, in terms of the environmental impacts and risks. The Environmental Assessment Practitioner believes that the information contained within this ESR is adequate to allow MEFT: DEA to determine the environmental viability of the proposed project.

It is acknowledged that the project details may evolve during the detailed design and construction phases. However, these are unlikely to change the overall environmental acceptability of the proposed project and any significant deviation from what was assessed in this ESR should be subject to further assessment. If this was to occur, an amendment to the Environmental Authorisation may be required in which case the prescribed process would be followed.

11.4. Mitigation Measures

With the implementation of the recommended mitigation measures in this report as well as in the EMP, the significance of the planning and design, construction and operational phase impacts is likely to be reduced to a ***Low (negative)***. It is further extremely important to include an Environmental Control Officer (ECO) on site during the construction phase of the proposed project to ensure that all the mitigation measures discussed in this report and the EMP are enforced.

It is strongly advised that the proponent appoint suitably qualified professionals to design and supervise the construction of the services and other infrastructure. It is also advised to develop and implement a preventative maintenance plan, which shall be monitored and evaluated regularly.

It is noted that where appropriate, these mitigation measures and any others identified by the EC could be enforced as Conditions of Approval in the Environmental Authorisation.

11.5. Opinion with respect to the Environmental Authorisation

Regulation 15(j) of the EMA, requires *that the EAP include an opinion as to whether the listed activity must be authorised and if the opinion is that it must be authorised, any condition that must be made in respect of that authorisation*.

The construction of a world class oil refinery, which will be the first one in the country will augment the economic potential of Namibia and the Erongo Region, it will also enable innovation and the introduction of new technologies. Preliminary technical and marketing studies point to a viable project that has relevance across multiple sectors of the economy, as it aims to provide solutions to the country's energy needs and lessen dependency from external suppliers. It does not only target the Namibian market but also has great potential to supply the regional fuel demand. The construction of the oil refinery will create new job opportunities both during construction and operation phases.

Legal pressure on industries and pressure from organizations urging them to protect and control the environment is growing daily. To comply with this legal pressure, potential polluters should choose not only pollution control but also pollution prevention. There are a huge number of options to achieve this, and it is advisable to adopt a systematic approach to evaluate these procedures.

Based on the evidence produced during the assessment process and the implementation of the recommended mitigation measures, it is unlikely that this project will have any significant negative impacts on the environment. It is therefore recommended that a clearance certificate be issued for the project.

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