FINAL ESIA REPORT

FOR

THE PROPOSED MM FZE PORT PROJECT

AT

FEDERAL OCEAN TERMINAL, ONNE PORT COMPLEX,
ONNE, ELEME LGA, RIVERS STATE, NIGERIA

BY

MELIORA METHANOL FREE ZONE ENTERPRISE (MM FZE)
FEDERAL OCEAN TERMINAL, ONNE PORT COMPLEX,
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LIST OF ABBREVIATIONS

AoI	Area of Influence
%	Percentage
µg/m3)	Microgram per cubic metre
0C	Degrees Celsius
AfDB	African Development Bank
AIP	alien invasive plant
ANSI	American National Standards Institute
AQS	Air Quality Standards
AR	Assessment Reports
ASME	American Society of Mechanical Engineers
ATA	Agriculture Transformation Agenda
BCF	Bill Cubic Feet
BOD	Biochemical Oxygen Demand
CAGR	Compound Annual Growth Rate
CCRA	Climate Change Risk Assessment
CDC	Community Development Committee
CDT	Climate Data Tool
Cm	Centimetre
CO	Carbon monoxide
CO_2	Carbon dioxide
COD	Chemical Oxygen Demand
COP	Conference of the parties
CPUE	Catch Per Unit Effort
CR&D	Community Relations and Development Department
CSR	Cooperate Social Responsibility
CX1	Control Station 1
dB	Decibel
dBA	Decibel
DD	Data Deficient
DM	Demineralised Water
E&S	Environment and Social
EAD	Environmental Assessment Department
EAE	Environment Agency for England
ECSL	Environmental and Chemical Services Ltd
Eff1	Effluent station 1
EHS	Environmental, Health and Safety
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
EPC	Engineering Procurement Construction
EPCL	Eleme Petrochemical Company Limited
EPFI	Equator Principle Founding Institute
ERM	Environmental Resources Management Southern Africa (Pty) Ltd

ESCL	Environmental & Chemical Services Limited
ESIA	Environmental and Social Impact Assessment
ESMMP	Environmental and Social Management and Monitoring Plan
ESMP	Environmental and Social Management Plan
ESMS	Environmental and Social Management System
ETP	Effluent Treatment Plant
EXO	exotic cultivated
FEPA	Federal Environmental Protection Agency
FGD	Focus Group Discussions
FIRS	Federal Inland Revenue Service
FMEnv	Federal Ministry of Environment
FZE	Free Zone Establishment
GBVH	Gender Based Violence and Harassment
GCD	Global Climate Database
GCMs	Global Climate Models
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GIIP	Global International Industry Practice
GMP	Grievance Management Procedure
GPHC	Greater Port Harcourt City
GPS	Global Positioning System
GTG	Gas Turbine Generators
H^+	Hydrogen ion
H_2S	Hydrogen Sulfide
Ha	Hectares
HP	High Pressure
HR	Human Resources
HRSG	Heat Recovery Steam Generators
HSE	Health, Safety and Environment
HTS	High Temperature Shift
HUB	Hydrocarbon utilising Bacteria
HUF	Hydrocarbon utilising Fungi
ICE	International Electrotechnical Commission
ICOMOs	International Council on Monuments and Sites
ICT	Information Communication Technology
IEEE	Institute of Electrical and Electronics Engineers
IEFCL	Indorama Eleme Fertilizer and Chemicals Limited
IEPL	Indorama Eleme Petrochemical Limited
IFC	International Finance Cooperation
IFL1	Indorama Fertilizer Line 1
IFL2	Indorama Fertilizer Line 2
IFL3	Indorama Fertilizer Line 3
ITF	Industrial Training Fund
IHR	International Health Regulation

ILO	International Labour Organization
IPCC	Inter-Governmental Panel on Climate Change
IPs	Indigenous Peoples
IR	Industrial Relations
IRC	Indorama Recreational club
ISBL	Inside Battery Limit
IUCN	International Union for Conservation of Nature
kg/cm2	Kilogram force per square centimetre
kg/ha	Kilogram Per Hectare
kg/hr	Kilogram Per Hour
KIIs	Key Informant Interviews
KL	Kilolitres
KPI	Key Performance Indicator
KTA	Kilo Ton Per Annum
kWh	Kilowatt per Hour
L1	Location 1
LC	Least Concern
LFN	Laws of the Federation of Nigeria
LGA	Eleme Local Government Area
lt/day	Litre Per Day
LTS	Long-Term Strategy
LTV	Long-term Vision
m3	Cubic Meters
m3/hr	Cubic Meter Per Hours
mamsl	Metres above mean sea level
mbar	Millibar
mbgl	Meter below ground level
MDEA	Methyl diethanolamine
mg/l	Milligram Per Litre
mg/Nm3	Milligrams Per Normal Cubic meter
mg/m3	Milligrams Per Cubic meter
Mm	Millimetre
MMBTU/MT	Million Metric British Thermal Unit/Metric Ton
MMFZE	Meliora Methanol Free Zone Enterprises
MMSCF	Million Standard Cubic Feet
MMSCFD	Million Standard Cubic Feet Per day
MMTPA	Million Metric Tonne Per Annum
MoU	Memorandum of Understanding
MSDS	Material Safety data Sheet
MTPD	Metric Tons Per Day
MW	Megawatt
MWH	Megawatt Per Hour
N2O	Nitrous oxide
NACE	National Association of Corrosion Engineers

NCCC	National Council on Climate Change
NE	Not Evaluated
NESREA	National Environmental Standards and Regulations Enforcement Agency
NFPA	National Fire Protection Association
NG	Natural gas
NGFCP	Nigerian Gas Flare Commercialization Program
NGOs	Non-Governmental Organisations
NH_3	Ammonia
NiMET	Nigerian Meteorological Agency
NIS	Network Information Service
NMDPRA	Nigerian Midstream and Downstream Petroleum Regulatory Authority
NMPSSAN	Non-Metallic Senior Staff Association
NNPC	Nigerian National Petroleum Cooperation Limited
NO2	Nitrogen Dioxide
NOX	Nitrogen oxide
NOx	Oxides of Nitrogen
NPA	Nigerian Ports Authority
NPK	Nitrogen (N), Phosphorus (P) and Potassium (K).
NSDWQ	Nigerian Standard for Drinking Water Quality
NSITF	Nigeria Social Insurance Trust Fund
NSR	Noise Sensitive Receptor
NT	Near Threatened
O&M	Operation and Maintenance
ODS	Ozone-depleting substances
OIPL	OIS Indorama Port Limited
OIS	Oil & Industrial Services Limited
OPRC	Oil Pollution Preparedness, Response, and Co-operation
OS	Operational Safeguard
OSH	Occupational Safety and Health
PAC	Project Advisory Committee
PAYE	Pay As You Earn (Tax)
PC	Process Contribution’
PEC	Projected Environmental Concentration’
PET	Polyethylene Terephthalate
PM	Particulate Matter
PM10	Particulate Matter of 10 diameter
PM2.5	Particulate Matter of 2.5 diameter
PPE	Personal Protective Equipment
ppm	Part per million
PS	Performance Standards
RH	Relative humidity
RIWAMA	Rivers State Waste Management Agency
RoW	Right of Way
RSEPA	Rivers State Environmental Protection Agency

RSMEnv	Rivers State Ministry of Environment
S	South
SDG	Sustainable Development Goal
SE	Southeast
SED	Socio-Economic Development
SED01	Sediment Station One
SEP	Stakeholder Engagement Plan
SIA	Social Impact Assessment
SO2	Sulphur Dioxide
SON	Standard Organization of Nigeria
SOP	Standard Operating Procedures
SPSS	Statistical Package for the Social Sciences
SSA	Sub-Saharan Africa
SSPs	Socio-economic Pathways
SSPS	Shared Socio-economic Pathways
STP	Sewage Treatment Plant
SW	Surface Water
TCLP	Toxicity characteristics leaching procedure
TDS	Total Dissolved Solids
THB	Total Heterotrophic Bacteria
THF	Total heterotrophic Fungi
TMP	Transportation Management Plan
ToR	Terms of Reference
UF	Urea Formaldehyde
UK	United Kingdom
UNFCCC	United Nation Framework Convention on Climate Change
USA	United State of America
USAID	United States Agency for International Development
USD	United State Dollar
UV	Ultraviolet
VAPP	Violence against Persons (Prohibition) Act
VOCs	Volatile organic compounds
VPSHR	Voluntary Principles on Security and Human
WBG	World Bank Group
WHO	World Health Organization
WMP	Waste Management Plan
WRI/ WBCSD	World Resources Institute/World Business Council for Sustainable Development
WRP	Water Recovery Project
wt	Weight

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0. EXECUTIVE SUMMARY

0.1 Introduction

Meliora Methanol Free Zone Enterprise (MM FZE), a subsidiary of Indorama Group has commissioned Environmental and Chemical Services Ltd (ECSL), Port Harcourt, Rivers State, Nigeria and Environmental Resources Management Southern Africa (Pty) Ltd (ERM) to undertake an Environmental and Social Impact Assessment (ESIA)[4] study for the proposed construction and operation of the MM Port FZE Facility at the Federal Ocean Terminal, Onne Port Complex, Onne, Eleme Local Government Area, Rivers State, Nigeria (hereafter referred to as the Project).

The proposed Project entails the construction and operation of a new Port terminal with all associated utilities to export Urea and Ammonia. The new terminal will be situated within the existing Onne Port Complex approximately (approx.) 20 kilometers (km) to the south of the manufacturing site at the existing Indorama Complex. The terminal will have one berth with a capacity to handle and export 1.4 Million Metric Tonnes per Annum (MMTPA) of granulated Urea and about 150 Kilotons per Annum (KTA) (which is approximately 420 Million Metric Tonnes per Day (MTPD)) of Ammonia.

0.2 Objective

This ESIA study has been conducted in line with the National EIA Procedural and Sectoral Guidelines, as well as ensuring consideration of relevant best practices, international standards, and guidelines. A detailed description of the policy, legal and institutional framework is provided in Chapter 1 of this Report. The ESIA study involved the following key activities: scoping, literature review, collection of baseline data, stakeholder engagement, impact identification and evaluation, development of mitigation measures and an Environmental, Social Management and Monitoring Plan (ESMMP), and report writing.

The specific objectives of the ESIA study are to:

- Provide a detailed description of the proposed Project (including relevant alternatives) in terms of the planned activities and the expected environmental and social (E&S) aspects associated with the activities.
- Establish the existing state of the E&S conditions and to identify any sensitive resources and receptors.
- Identify and assess the associated and potential E&S impacts and risks of the Project, including potential secondary and cumulative impacts.
- Recommend appropriate mitigation measures (adopting the mitigation hierarchy, which is a set of guidelines that aim to achieve no overall negative impacts through the avoid, minimise, restore and offset sequential steps) to address the identified impacts of the Project.

[4] The use of the term ESIA as opposed to Environmental Impact Assessment is to emphasize that the process will not only assess environmental impacts but will also assess potential socio-economic impacts of the proposed Project.

- Develop an appropriate ESMMP to detail how mitigation measures will be implemented and how environmental performance will be managed for the project throughout the Project's life cycle.
- Prepare and submit a detailed ESIA Report presenting clear and concise information on the findings of the ESIA study.

0.3 Justification for the Project

The likely positive benefits associated with the Project include the opportunity to supply an ever-increasing global demand for fertilizer, increased access to fertilizer to Nigeria and other West African countries, creation of employment for approximately 705 personnel (32 experts' staff and 673 national staff) during the construction and pre-commissioning phase and approximately 220 personnel (10 experts' staff and 210 national staff) during the operational phase. Furthermore, the Project will improve the following areas of the economy: improvement of the local economy in the immediate Project Area, development of other downstream medium scale industries such as shipping, as well as the creation of foreign exchange for exported ammonia and urea.

In terms of Project alternatives, a transport route has been identified from the manufacturing site to the new terminal to ensure efficient transport of urea and ammonia by means of covered tipper trucks. While alternative location alternatives are reasonable, it is not financially feasible (or reasonable) to identify other sites at this stage, as there are no environmental and social (E&S) fatal flaws or red flags associated with the proposed location of the Project.

The Project will use the same technology employed for the development of OIPL in Onne, Nigeria, which has demonstrated a high degree of operability and reliability. The Project will therefore employ a traveling ship-loader mounted on rails. Travelling loader facilities are the more efficient compared to stationary bulk loader. Additionally, the Project will include bulk storage and loading systems. The use of mechanical handling systems present minimal health and safety risks and minimal exposure of potential pollutants to the environment. As such, although technological alternatives in terms of design and technology are reasonable, it is not financially or environmentally reasonable.

A detailed description of the justification for the Project and an analysis of alternatives is proved in Chapter 2 of the ESIA Report.

0.4 Project Description

0.4.1 Project Location

The Project area borders undeveloped land to the north, and east, the Operational Onne Multipurpose Terminal (OMT) to the west and waterfront at the south. The total footprint of the Project is 20 hectares (ha). The coordinates of the Project Site are Latitude 4^{0}50'3" to 4^{0}50'52" N and Longitude 7^{0}6'29" to 7^{0}6'55" E.

0.4.2 Project Design

The Project design in terms of equipment design, layout, etc. is similar to the already operating Indorama's OIS Indorama Port Limited. MM FZE has already engaged an Engineering Contractor for the Project. For the purposes of this ESIA, the following regarding the Project is important to note:

- Project design is such that the Project will have an operational lifespan of 30 years.
- Design capacity is such that the Plant will operate 330 days/year.

The new port terminal will house the Urea storage and handling system, the Ammonia storage and handling system, as well as the associated facilities are detailed in the Sections which follow. The new port terminal will have facilities as mentioned below:

- Intake system
  - Truck weighbridges (incoming and outgoing).
  - Truck unloading station (TUS) simultaneously four trucks.
  - Conveying system from TUS to urea storage by means of belt conveyors, bucket elevator and reversible shuttle conveyor.
  - De-dusting system.
- Storage
  - Warehouse having capacity 52000 MT
  - Air handling unit
- Outtake system
  - Portal reclaimer
  - Belt conveyors
  - Ship loader on jetty
  - De-dusting systems
  - Belt weigher
- Ammonia Storage and Handling
  - Ammonia Tanker Unloading System
  - Ammonia Storage Tanks
  - Flare stack for Ammonia Storage Tank
  - BOG Reliquefication Unit
  - Ammonia Ship Loading Pumps
- Jetty top side facilities
  - Ammonia Loading Arms
  - Urea Loading System

- Utilities and Other Facilities
  - Cooling Water System for BOG Unit and air compressors
  - Plant air, Instrument Air Unit, and nitrogen storage
  - Natural gas-powered generation unit inclusive of substation and distribution unit.
  - Compressed Natural Gas (CNG) storage modules.
  - Two borewells, each with a capacity of 20~25 cubic metres per hour (m3/hr).
  - Storage of groundwater from the two borewells, treatment, and distribution system.
  - Sewage treatment plant
  - Two weighbridges of 100 Metric Tonnes (MT).
  - Firefighting System Fire water pumps (sea water) and fire water network.
  - Fire & Gas Detection and Protection System.
- Buildings: The new port terminal will also have below mentioned buildings,
  - Workshop / Maintenance area
  - Storage area for lubrication Oil and water treatment chemicals
  - Security Building
  - Administration Building

0.4.3 Construction Phase

The construction phase will not commence prior to the approval of the ESIA study. It is assumed that construction will take approx. 22 months. Activities during the construction phase will typically involve excavation works, concrete casting, civil works (specifically equipment foundations), installation of prefabricated structures & equipment, and establishment of the infrastructure. It should be noted that no construction activities will be undertaken during the night.

0.4.4 Operational Phase

The operational phase will comprise of the following:

0.4.4.1 Detailed Project Facilities and Process

The new port terminal will be used for exporting 1.4 MMTPA Urea and 150 KTPA of Ammonia. The block process flow of Ammonia and Urea handling and detailed description of the proposed facilities is provided in Chapter 3 of this ESIA Report:

0.4.4.2 Urea Storage and Handling

Urea produced at the manufacturing site will be transported to the new port terminal through covered tipper trucks with 40 MT payload capacity. Urea will be unloaded and stored in the Urea warehouse and loaded to Ultramax and Handymax bulk carriers.

0.4.4.3 Ammonia Tanker Unloading Station

Ammonia produced at the manufacturing site will be transported to the new port terminal by dedicated ISO tankers. The ammonia will be unloaded and stored in the Ammonia Storage Tank for export.

The Detailed Engineering Contractor (DEC) will undertake the engineering of the tanker unloading station for the receipt/unloading of liquid ammonia. Ammonia will be transported from the manufacturing complex to the Project by dedicated tankers. The unloading station will have all the facilities required to unload two tankers of approximately 20 MT capacity each, simultaneously within an hour. The expected surplus liquid ammonia receipt at the new port terminal will be about 420 MTPD (150 KTA).

0.4.5 Decommissioning Phase

Activities during the decommissioning phase will involve demolition and site clean-up, disposal of waste, demobilization of the workers, and a final site review. While the equipment and structures installed on the jetty will be demolished, the jetty itself will remain. Decommissioning will take place years from now, and the baseline conditions associated with the Project and surrounds are likely to be significantly different to what it is today. When the new port terminal Project reaches its end of life and should decommissioning be required then this would need to be assessed under a separate ESIA process.

0.5 Key Sensitivities

Key physical, biophysical, and socio-economic sensitivities identified in the Study Area include:

0.5.1 Key Physical Environmental Sensitivities

- **Geology**: the geology underlying the Project Site mainly consists of unconsolidated sand. Due to its loose sandy nature, the geology can be classified as sensitive to impacts from dredging and installation of bored piles.
- **Soil:**
  - The soil on site is reclaimed with river sand, which dominates soil aggregates, making it friable both at wet and dry. The soils are sensitive to structure foundations.
  - Due to the relatively high permeability of the soil, contamination from chemical and hydrocarbon spills on surfaces can easily enter the soil and migrate away from the pollution source at a relatively high velocity, further impacting the soils away from the pollution source.
  - Shallow excavations during construction of surface infrastructure can disturb the soil structure and increase soil erosion.

- **Groundwater**:
  - The groundwater in the Project area is associated with the unconsolidated sandy layers of the deltaic aquifer. The groundwater level is shallow at between 0 and 9 m depth. The aquifers are sensitive to potential contamination from surface water.
  - It is planned that two water supply wells will be installed, and it is estimated that 10m3/day will be used for potable water, and 10m3/day for service water. These volumes are relatively low and are not expected to have a notable impact on the overall groundwater availability in the sub-catchment. However, abstraction of groundwater from these water supply wells is expected lead to a drawdown in the groundwater level in the surrounding aquifers, which in turn may lead to saltwater intrusion from the Bonny River. Sodium and chloride concentrations in the Bonny River is measured to range around 3,500mg/L and 6,200mg/L respectively, while the sodium and chloride concentrations in the aquifers are measured to be in the order of 10 – 280mg/L and 20 – 700mg/L respectively. Saltwater intrusion into an aquifer is almost impossible to mitigate and can have an impact on surrounding groundwater users as well.
  - During the construction phase, heavy machinery will be operational on site. The spill can enter the soil and migrate vertically into the underlying aquifers from where it will migrate away from site. The extent and severity of these impacts are expected to be relatively low, but it is likely to remain in the soil and groundwater for a prolonged period. Remediation will be difficult.
- **Bonny River:** the sub-catchment within which the site is located, is drained by the Bonny River, which forms the southern site boundary. The Bonny River is characterized by deep and shallow channels with semi diurnal tides that generate tidal current in phase with the tidal direction. The River is further characterized with strong currents, sandbars, and erosion. It is also sensitive to saltwater intrusion caused by tidal currents.
- **Dredging:** The berth pocket in front of the quay where the vessel will be moored, will be dredged to a depth of approximately 13m. The dredging will temporarily increase turbulence and suspended solids in the water, but the longer-term impact will be on the river channel shape, which could impact the flow characteristics. However, it should be noted that the area where dredging will take place measures approx. 450m and is a small percentage (<1%) of the total river channel area. The natural stream flow volumes are high with natural elevated suspended solids. There are also numerous other companies in the area that already conduct dredging / bed sweeping, therefore, the river sensitivity to the impacts is reduced).

0.5.2 Key Biophysical Sensitivities

- **Terrestrial Biodiversity:** the Project area contains modified and sand-filled areas (dominated by grasses and sedges), patches/relics of riparian mangrove vegetation along the quay-side, and secondary forest consisting of mangrove swamp vegetation (across the river body, about 2.3 km away from the proposed Project site). Despite indigenous species being present within habitats on and adjacent to the Project site, these are modified and under immense pressure from alien invasive plants.

- **Aquatic Biodiversity:** the estuarine biodiversity in the site has already been highly impacted, with mangroves largely removed. However, the site still has the limited potential to support important estuarine biodiversity, particularly on the intertidal mudflats. The Project will remove any remaining intertidal estuarine habitat on the limited area of the site., for which biodiversity offset in terms of the requirements of PS6 is advised.

0.5.3 Key Socio-economic Sensitivities

- **Impacts on Natural Resource-based Livelihoods**: the communities in the Project area and surrounds rely heavily on agriculture and land use for their livelihoods. Any potential loss of environmental habitats or biodiversity loss will impact the surrounding communities negatively. Additionally, it was found that the surrounding communities also rely on fishing as a source of livelihood. Any impact to this during the construction and operation phase, such as increased pollution levels and water contamination, may result in impacts on natural resource-based community livelihoods.
- **Water Contamination**: surrounding communities rely on groundwater (boreholes and wells), as well as surrounding rivers and oceans as water sources. If any of these water sources become polluted, community livelihoods and household activities will be impacted.
- **Proximity of Communities to Site**: the construction phase could result in disruption to nearby communities to the north and north-west. The access to the site (roads and entrances) should be considered to minimise impacts to adjacent communities.
- **Construction Noise, Dust, Traffic:** such aspects must be managed to prevent impacts on nearby communities.
- **Changes in Local Air Quality:** mainly could negatively impact local communities, who are considered vulnerable due to their (assumed) low socio-economic status.
- **Site Access through Onne Community:** primary access to the site is along the main roads, including Ejaka-Wakanda Road, which runs through the centre of the Onne community. Increased presence of heavy vehicles during construction, as well as trucks carrying urea for export during operation, may have an impact on traffic levels as well as the quality of local roads. Furthermore, the movement of heavy vehicles through a densely populated town centre presents several hazards such as traffic accidents or injuries or fatalities of pedestrians.
- **Reduced Community Cohesion and Access to Basic Services:** mainly due to influx of labour and outsiders during the construction phase.
- **Unmet Expectations**: for local employment, procurement, and socio-economic development.
- **Disruption to Fishing Livelihoods**: through environmental impacts and port traffic.
- **Community Health and Safety risks:** due to construction activities and security personnel.
- **Traffic:** existing levels of congestion on the East West Highway, which connects south-eastern Nigeria to Port Harcourt, are anticipated to increase due to increases in peak hour traffic, large vehicle traffic, and turning movements at the New Road Junction and Onne Road resulting from

the MM FZE Project. Congestion on the route from the Port of Onne to the East West Road may increase due to increased truck traffic. Project-related vessel traffic will incrementally increase vessel congestion and risk of marine casualty events on the Bonny River

0.6 Impact Assessment

An extensive risk assessment was undertaken during the ESIA process where a range of potential impacts to the physical, biological, and social environment were identified and assessed. Where risks and impacts have been identified, appropriate mitigation measures have been provided in the ESIA. It should be noted that for many of the impacts identified, the proposed mitigation measures will reduce the significance of the impacts to a minor or negligible level. However, for some impacts, even with mitigation, residual impacts will remain. Those impacts that have a moderate to major post-mitigation (residual) significance, and which will require careful and consistent ongoing management, include:

- **Underwater Noise**: Impacts related to underwater construction noise on mammals and other estuarine biota other mammals. The most sensitive receptors are likely to be the IUCN Critically Endangered Atlantic Humpback Dolphin, which is a highly noise-sensitive species.
- **Accidental/Potential Spills**: Impacts related to potential spills of ammonia, Urea, fuel spills and catastrophic loss of containment would affect a wide range of organisms, including those important for ecosystem services such as fisheries.
- **Road Safety Risks**: Local road users, including market traders, pedestrians, and local vehicular traffic, are sensitive to potential road safety impacts. Groups such as school children, pregnant women, and people with disabilities are particularly vulnerable to road safety incidents.
- **Construction of Surface Infrastructure**: The soils of the site have a medium sensitivity. Disturbance of the soil can lead to increased erosion, and contamination from surface can migrate towards the water table where it joins the saturated zone.
- **Saltwater Intrusion on the Groundwater Resource**: abstraction of groundwater from the water supply wells is expected lead to a potential drawdown in groundwater level in the surrounding aquifers, which in turn may lead to saltwater intrusion from the Bonny River
- **Chemical and Hydrocarbon Spills on the Groundwater Resource** may arise from heavy machinery and vehicles operational on site.
- **Transport, Loading and Storage of Urea and Ammonia**: During transport, unloading of the transport trucks and tankers, and conveying of urea and ammonia into the urea warehouse and Ammonia Storage Tanks, accidental spills could occur, which could impact the groundwater resource quality.
- **Unforeseen Impacts on Terrestrial Biodiversity**: Moderate to high volumes of hydrocarbons could be spilled on the site or quay, and rapidly move into water from where downstream or nearby habitats may be polluted, of which mangroves are likely to be most impacted. Moderate to high volumes of ammonia and/or urea could be spilled and rapidly spread into surrounding habitats and/or be transported further by water. Emergency flaring, if required, may catch fauna unawares

and cause injury or death, especially if this occurs at night, affecting fauna happening to be in close proximity to the flare stack.

- **Unplanned events**: including fuel spills and other pollution, spills of ammonia-derived products and loss of containment.

Moreover, some more studies were undertaken to understand baseline for groundwater, surface water resources and aquatic biodiversity. The outcome of these studies undertaken during dry season (January 2024) are included in this final ESIA report.

The ESIA process should not stop with the submission of this ESIA report and associated ESMMP to FMEnv. Upon submission, there will be need for continued work and monitoring of environmental components. Where any changes are observed, these will be assessed in terms of their potential to alter the ESIA findings. Some changes may not result in a material change to the ESIA findings; however, any further changes to Project scope should be re-evaluated in terms of the influence on impact significance, and if necessary, mitigation / management measures included in the ESMMP will be amended to ensure negative impacts are mitigated and positive impacts enhanced. Typically, such substantive changes will be submitted as an addendum to this ESIA.

0.7 Impact Mitigation

Potential mitigation measures were prescribed to avoid, minimize, reduce, or compensate for potentially identified negative impacts and also enhanced positive impacts according to the project phases.

0.8 Environmental and Social Management Plan

Environmental management plan was discussed according to the different environmental components to create effective monitoring measures on residual impacts. To provide the vehicle for the integrated management of the potential impacts identified in the ESIA (both positive and negative) an Environmental and Social Management System (ESMS) will need to be implemented. The ESMS provides a mechanism for ensuring that mitigation measures identified in the ESIA and associated ESMMP are adequately implemented. Moreover, the ESMS provides a framework for monitoring, compliance auditing and inspection programmes, which assist the Project in meeting its commitments, as stipulated in Nigerian regulations and lender standards (primarily the IFC PSs).

0.9 Conclusion

Provided that all the E&S mitigation / management measures provided in this ESIA Report and associated ESMMP are implemented, it can be concluded that there are no E&S fatal flaws which inhibit authorisation of the proposed MM FZE Project.

Moreover, the positive benefits of the proposed Project also need to be considered in the authorisation decision. These positive benefits, provided in more detail under the Project Justification (Chapter 2), include: improving regional fertilizer supply and ultimately impacting positively to food security of the world and Africa at large, generation of revenue to the country contributing to Nigeria's goal to becoming a net exporter of Urea fertilizer in the region and the provision of new employment opportunities for the growing demand from the young Nigerian population. With all three IEFCL units (Train1, 2 & 3) in operation, MM FZE will use the new Port Terminal to export the surplus 150KT ammonia and 1.4 million tons of urea. Overall, the Project will be able to derive valuable foreign exchange from the Urea and Ammonia that will be exported, as well as improve the local economy in the immediate Project area.

ACKNOWLEDGMENT

The management of Meliora Methanol Free Zone Enterprise (MM FZE) wishes to acknowledge with thanks, the opportunity granted by the Government of Federal Republic of Nigeria through the Federal Ministry of Environment (FMEnv), the Rivers State Ministry of Environment (RSMEnv) and the Nigerian Ports Authority (NPA) to carry out this Environmental and Social Impact Assessment Study (ESIA) for the proposed “MM FZE Port Project”.

MM FZE appreciate the cordial working relationships had with the Federal Ministry of Environment, the Rivers State Ministry of Environment, the Nigerian Ports Authority, Eleme, and Ogu/Bolo Local Government Council during ESIA study. MM FZE acknowledge the support of the Royal Majesty the King of Eleme Land, Chiefs, Clan Heads, Women and Youth Groups, NGOs, Individual and other community-based organizations for their support during this study especially during the stakeholder’s engagement.

MM FZE also acknowledge and appreciate the supports of others, who extended their services and support to help in executing this ESIA study.

Thank you,

Management of MM FZE

CHAPTER – ONE

INTRODUCTION

Meliora Methanol Free Zone Enterprise (MM FZE), a subsidiary of Indorama Group has commissioned Environmental and Chemical Services Limited, Nigeria and Environmental Resources Management Southern Africa (Pty) Ltd (ERM) to undertake an Environmental and Social Impact Assessment (ESIA)[1] study for the proposed construction and operation of the MM Port FZE Facility at the Federal Ocean Terminal, Onne Port Complex, Onne, Eleme Local Government Area, Rivers State, Nigeria (hereafter referred to as the Project).

1.1 Project Overview and Background

Meliora Methanol Free Zone Enterprise (MM FZE), a subsidiary of Indorama Group proposed the construction and operation of the Port Facility to export Urea and Ammonia, at the Federal Ocean Terminal, Onne Port Complex, Onne, Eleme Local Government Area, Rivers State, Nigeria. The Urea and Ammonia to be exported from this proposed Port Terminal will be manufactured by IEFCL at Indorama Complex, Eleme, Rivers State.

IEFCL is a major producer of urea fertilizer, with a facility situated on a site of approximately 51 hectares (ha) within the 361 ha Indorama manufacturing complex at Eleme, Nigeria. The operations consist of petrochemical manufacturing facilities run by Indorama Eleme Petrochemicals Limited (IEPL) and fertilizer manufacturing facilities that are run by Indorama Eleme Fertilizer and Chemicals Limited (IEFCL) within the Indorama manufacturing complex. Current manufacturing capacity is 2.8 MMTA of Urea & 400 KTA of Polymers (Polyethylene & Polypropylene), utilizing Natural Gas & Natural Gas Liquids as feedstock. The Petrochemical manufacturing facilities comprising of the Cracker, Polyethylene and Polypropylene plants have been in operation since 2006. The Fertilizer manufacturing facilities consist of the Train 1 and Train 2 lines, which both independently produce 2,300 and 4,000 metric tons per day (MTPD) of ammonia and urea respectively. It should be noted that an ESIA study was commissioned for Train 3 in January 2023, and this Report was submitted to the Federal Ministry of Environment (FMEnv) on 26th May 2023 and International Finance Corporation (IFC) for approval. The Train 3 expansion project consisted of the development of an additional ammonia and urea train, with a design capacity of 2,300 MTPD of ammonia and 4,000 MTPD of urea. This ESIA Report was approved by the Federal Ministry of Environment (FMEnv) vide letter number FMEnv/EA/EIA/6063/Vol.1/243 dated 6th September 2023.

After the commissioning of the IEFCL Train 3 expansion Project, there will be surplus ammonia of approximately 420 MTPD over and above the amount required for the Urea plants. IEFCL is planning to export this surplus liquid ammonia and 1.4 Million Metric Tonnes per Annum (MMTPA) of Urea to

[1] The use of the term ESIA as opposed to Environmental Impact Assessment is to emphasise that the process will not only assess environmental impacts but will also assess potential socio-economic impacts of the proposed Project.

West African counties, Brazil and other Latine Arican counties through the facilities at the proposed MM Port Terminal.

The proposed Project entails the construction and operation of a new Port terminal with all associated utilities to export Urea and Ammonia. This new terminal is proposed to be situated within the existing Onne Port Complex about 20 km to the south of the manufacturing site at the existing Indorama Complex (Figure 1-1). The Onne Port complex is located with Eleme LGA. The location of Eleme within Rivers State in Figure 1-2 and the location of Rivers State in Nigeria is shown in Figure 1-3. The terminal shall have one berth with a capacity to handle and export 1.4 MMTPA of granulated Urea and about 150 Kilotons per Annum (KTA) (which is approximately 420 Million Metric Tonnes per Day (MTPD)) of Ammonia. Moreover, the terminal will include separate Urea and Ammonia storage and handling systems and associated facilities, including – a quay designed for mooring and loading of vessels; a boil of gas (BOG) unit for compression and liquification of ammonia vapours; an ammonia pumping station from the storage tank to ship; a jetty loading system for Urea; and a jetty loading arm for Ammonia. The Project also includes a compressed natural gas storage module to be used for power generation. Power generation will be by means of three gas engine generators with a capacity of 1,500 (Kilovolt Amperes) kVA and one generator with a capacity of 800 kVA. The number of generators, capacity and generating voltage shall be confirmed during detailed engineering phase of the Project. Natural gas shall be stored at high pressure in a stationary cascade at the terminal.

Additionally, the Project entails the development of the following utilities and other facilities required for project operation:

- Cooling water system for the BOG Unit and air compressors.
- Plant air, instrument air unit (packaged unit) and nitrogen storage.
- Natural gas-powered generation unit inclusive of substation and distribution unit.
- Compressed Natural Gas (CNG) storage modules.
- Two borewells, each with a capacity of 20 meters cubed per hour (m^3/hr).
- Storage of groundwater from the two borewells, treatment, and distribution system.
- Two weighbridges of 100 metric Tonnes (MT).
- Firefighting System Fire water pumps (sea water) and fire water network.
- Fire & Gas Detection and Protection System.

Further, the Project contractor will construct the following buildings on the jetty needed for operations:

- Workshop/maintenance area.
- Storage area for oil and chemicals.
- Security building.
- Administration building.

The details of these buildings will be provided during detailed engineering phase.

Figure 1-1: Project Locality

Figure 1-2 – Administrative Map of Rivers State showing Eleme LGA

Figure 1-3 – Administrative Map of Nigeria showing Rivers State

1.2 Project Proponent

The proponent of the proposed Project is MM FZE, Federal Ocean Terminal (FOT), Onne Port Complex, Oil & Gas Free Zone, Onne, Eleme LGA, Rivers State. It is the proponent's intent to establish the new Port Terminal facility, from concept to construction and subsequent commissioning & operation in line with the National Guidelines on infrastructure sector and in accordance with international best practice (IBP). MM FZE is a subsidiary of Indorama Group and owned by Indorama Group. Indorama Group is globally operating in four continents and currently have 182 manufacturing sites. Indorama is effectively operating OIPL Terminal located within Onne Port Complex since last 8 years without any environmental incident and no non-compliance to regulations and laws.

1.3 Environmental and Social Impact Assessment Team

The proposed ERM ESIA team has experience in undertaking ESIA studies, which need to be compliant with both Nigerian legal requirements and IBP requirements. Moreover, the team has a range of Subject Matter Experts (SMEs) to support local baseline data collection efforts and to undertake the necessary impact assessments as required. The baseline data collection was done by M/s Environmental and Chemical Services Limited (ECSL), Port Harcourt, Nigeria. ECSL is an FMEnv accredited environmental consultancy outfit having rich experience in conducting ESIA & other environmental studies and have a team of experience professionals of various subject matters.

1.4 Objectives of the Environmental and Social Impact Assessment Process

The overall objective of this ESIA study is to proactively identify and evaluate the potential environmental and social (E&S) impacts of the Project; and to put in place appropriate mitigation measures and management actions to address the identified impacts.

The specific objectives of the ESIA study are to:

- Provide a detailed description of the proposed Project (including relevant alternatives) in terms of the planned activities and the expected environmental and social aspects associated with the activities.
- Establish the existing state of the E&S conditions and to identify any sensitive resources and receptors.
- Identify and assess the associated and potential E&S impacts and risks of the Project, including potential secondary and cumulative impacts.
- Recommend appropriate mitigation measures (adopting the Mitigation Hierarchy, which is a set of guidelines that aim to achieve no overall negative impacts through the avoid, minimise, restore, and offset sequential steps) to address the identified impacts of the Project.
- Develop an appropriate Environmental, Social Management and Monitoring Plan (ESMMP) to detail how mitigation measures will be implemented and how environmental performance will be managed for the Project throughout the Project's life cycle.
- Prepare and submit a detailed ESIA Report presenting clear and concise information on the findings of the ESIA study.

1.5 Scope of the Environmental and Social Impact Assessment Study and Report

In conducting the ESIA study, the following activities have been completed:

- Review of applicable national and international laws, regulations, agreements, and industry codes.
- Submission of Project registration form together with the Terms of Reference (ToR) to FMEnv.
- Scoping and advanced stakeholder engagement.
- Literature review of relevant information pertaining to the Project Area of Influence (AoI) and the wider study area.
- Consideration of Project alternatives.
- Description of all actions/activities that will be carried out in the course of the Project.
- Determination of the physical, biological, and socio-economic baseline conditions of the study area and identification of any baseline gaps and subsequent resolutions.
- Conducting an impact assessment and identifying the effect of Project activities on the existing baseline environment.
- Advise on the mitigation of significant adverse effects of the Project during all phases.
- Recommendation of appropriate mitigation measures (including any further post-ESIA E&S commitments), including the development of an ESMMP; and
- Response to the queries from stakeholders, Host Communities, regulators, and other interested parties.

1.6 Terms of Reference

In line with the requirements of the National Environmental Impact Assessment (EIA) Procedural and Sectoral Guidelines, a draft ToR for the ESIA study was prepared and submitted to the FMEnv along with the EIA registration application on 7th December 2022. The revised ToR was submitted in May 2023 after the scoping workshop. The ToR specified the technical scope of the ESIA study including the data requirements for determining the Project's environmental and social setting. The ToR was subsequently approved by the FMEnv on 12 May 2023, reference number FMEnv/EA/EIA/6791/Vol.1/113 (Annexure 1.1). The FMEnv also classified the Project as an EIA Category One (1) Project vide letter number FMEnv/EA/EIA/6791/Vol.1/86 dated 30th January 2023. (Annexure 1.2).

1.7 Legal and Policy Framework

The ESIA study for the Project is based on the provisions of the Nigeria EIA Act No 86 of 1992 (now codified as the EIA Act CAP E12 Law of the Federation of Nigeria, 2004). In September 2021, through Official Gazette No. 105, Vol 108, the Federal Republic of Nigeria published S.I. No. 109, Environment Impact Assessment (EIA) Procedures and Charges Regulations. This ESIA study has considered these regulations, which outline the National EIA process. The ESIA study has also considered the requirements of the International Finance Corporation's (IFC) Performance Standards (PSs) on Environmental and Social Sustainability (2012), the World Bank Group's (WBG) General guidelines, as well as relevant industry-sector Environmental, Health and Safety (EHS) guidelines and IEFCL Health, Safety and Environment (HSE) policy statements and Africa Development Bank (AfDB) Integrated Safeguards System (ISS). These standards include a requirement to assess the Environmental, Social and Health impacts of any development during all phases (planning, construction, and operation), so that adequate control measures can be undertaken to mitigate negative effects and enhance positive impacts.

This Section details the intricate foundational laws, regulations, policies, and guidelines both on national (Nigerian law) and international levels. The key institutional arrangements, administrative structures and legal instruments that relate to various activities applicable to the Project.

1.7.1 Institutional Framework

This Section provides a summary of the authorities with the mandate to implement aspects of Nigerian legislation over aspect relating to the Project.

1.7.1.1 Federal Ministry of Environment (FMEnv)

The Federal Ministry of Environment (FMEnv) is the principal authority for the regulation and enforcement of environmental laws in Nigeria. The EIA Act, established by the Ministry, which ensures that all development and industrial activities, operations and emissions are within the limits prescribed in the national guidelines and standards and comply with relevant regulations for environmental pollution management in Nigeria as and when these are released by the Ministry. Further to the Mandate, FMEnv developed laws/ guidelines on various sectors of the national economy including the Environmental Impact Assessment (EIA Act CAP E12, LFN 2004) Act and procedures for evaluating EIA reports. Furthermore, in September 2021, through Official Gazette No. 105, Vol 108, the Federal Republic of Nigeria published S.I. No. 109, Environment Impact Assessment Procedures and Charges Regulations. This ESIA study has considered these regulations, which outlines the EIA procedure from Project conception to commissioning and describes the requisite follow up activities. FMEnv consults with State Ministries of Environment and their Environmental Protection Agencies during the EIA permitting process. In addition, other regulatory agencies/authorities with oversight over specific industries have also issued guidelines to regulate the impact of such industries on the environment.

1.7.1.2 National Environmental Standards and Regulation Enforcement Agency (NESREA)

The National Environmental Standards and Regulations Enforcement Agency (NESREA) was established in 2007 by the Federal Government of Nigeria as an Agency of FMEnv. The Agency is charged with the responsibility of enforcing the environmental laws, guidelines, standards, and regulations in Nigeria, specifically during the operational phase of development projects.

1.7.2 National Regulatory Framework

The national policies and regulations included in Table 1-1 below have E&S implications that pertain to the Project and associated ESIA study.

Table 1-1: National Policies & Regulations

Governing Documents	Description	Applicability
National Policies		
National Policy on the Environment, 2017	The National Policy on the Environment, 1989 (revised 1999 and 2017), provides a national mechanism for routine coordination and consultation among various tiers of local, state, and federal governmentto improve the development and implementation of environmental policy as well as establish effective relationships. In doing so, this Policy aims to achieve sustainable development through conserving the environment and natural resources, raising public awareness between environmental resources development, maintaining, and enhancing ecosystem processes, and co-operating with other countries, organizations, and agencies to reduce transboundary environmental degradation.	In line with the aims of the policy, this ESIA study includes an assessment of impacts to the physical, biological and socio- economical environments related with the different phases of the Project. Moreover, this ESIA study includes mitigation measures and an associated ESMMP that aims to avoid /minimise/ manage the severity of identified impacts. Once the ESIA study is approved by the FMEnv, MM FZE will need to implement the commitments included and conduct periodic audits to ensure continuous improvement.
National Policy on Climate Change, 2021	The mission of the National Policy on Climate Change, 2013 (revised 2021) is to strengthen national initiatives to adapt to and mitigate climate change and involve all sectors of society, including the poor and other vulnerable groups (e.g., women, elderly, youth etc.) within the overall context of advancing sustainable socio-economic development. Its main objectives are to: ■ Implement mitigation measures that will promote low carbon as well as sustainable and high economic growth. ■ Strengthen national capacity to adapt to climate change. ■ Raise climate change-related science, technology, and researchand development to a new level that will enable the country to better participate in international scientific and technological co- operation on climate change. ■ Significantly increase public awareness and involve the privatesector in addressing the challenges associated with climate change; and	In line with the National Policy on Climate Change, 2013 and the Climate Change Act, 2021, this ESIA study has considered the climate change adaptation requirements for the Project and management relating to GHG emissions during all Project phases.

Governing Documents	Description	Applicability
	■ Strengthen national institutions and mechanisms (policy, legislative and economic) to establish a suitable and functionalframework for climate change governance.	
The National Gender Policy, 2021	The National Gender Policy, 2021 presents a set of minimum standards to meet the mandate for gender equality, good governance, accountability, and being socially responsive to the needs of vulnerable groups. The policy builds on the revision of the NGP, 2007 to respond to emerging issues across the sectors since 2006 and to incorporate current gender gaps to fulfil Nigeria's commitment to such global agenda as the SDGs. The strategic policy objectives are to bridge gender/social inclusion gaps, achieve parity in all spheres, to protect women's human rights, and mitigate sexual and gender-based violence through appropriate buffers and related services.	This ESIA process has (and continues) to be undertaken to ensure effective, transparent, and timely stakeholder engagement. Additionally, it has been structured such that all stakeholder engagement activities will take into consideration gender sensitivities, particularly when engaging with local communities. Moreover, the ESIA study considers gender equality in recruitment and that no employee or job applicant discriminated against on the basis of his or her gender, marital status, nationality, ethnicity, age, religion or sexual orientation.
National Policy on Occupational Safety and Health, 2021	The Occupational Safety and Health policy strengthens the National Labour Policy and extant labour legislations, provisions Cap 126, the workmen's Compensation Act Cap 470, Trade Union Act Cap 126, Trade Dispute Act Cap 432, wages Board and Industrial Councils Act 466 and the Labour Act Cap 198, and other relevant Laws of the Federation of Nigeria. The goal of the policy is to facilitate improvement of occupational safety and health performance by providing the framework for participative occupational safety and health protection of workers including the most vulnerable groups in all sectors of economic activities.	The safety, health, and welfare of all the workers associated with the Project will need to be addressed in line with all the provisions of this Policy throughout the Project lifecycle (construction, operational and decommissioning phases).
National Policy on Solid Waste Management, 2022	The National Policy on Waste Management 2022 provides a guidancefor efficient and sustainable solid waste management in Nigeria. The policy objective is to provide a national direction on solid waste management for the Federal, States, Local governments, private sector, and all stakeholders. In doing so, the policy aims to promote a healthy and aesthetically satisfactory environment by ensuring effective, sustainable, safe, and sanitary solid waste management.	The Project, during the construction, operational and decommissioning phases, will generate wastes, which will need to be disposed of as per the guidelines in this Policy. The ESMMP has considered these regulations and includes a section on solid waste management.

Governing Documents	Description	Applicability
National Environmental Sanitation Policy, 2005 (revised 2018)	This Policy serves as the instrument for securing sustainable quality environment for good health and social wellbeing of present and future generations.	This ESIA process has undertaken to cover events that could impinge on sanitation, hygiene, and health.
National Energy Policy, 2018	The national energy policy (2018) recognizes the multi-dimensional nature of energy and therefore addresses diverse issues such as research and development, energy pricing and financing, legislation, energy efficiency, environment etc. The overall thrust of the energy policy is the optimal utilization of the nation's energy resources for sustainable development with the active participation of the private sector. The policy aims to ensure the development of the nation's energy resources, with diversified energy resources option, for the achievement of national energy security and an efficient energy delivery system with an optimal energy resource mix and to guarantee adequate, reliable, and sustainable supply of energy at appropriate costs and in an environmentally friendly manner, to the various sectors of the economy, for national development. It also aims to successfully use the nation's abundant energy resources, promote research and development in, and adoption of, sustainable low carbon and clean energy technologies to mitigate environmental pollution and climate change and to ensure effective coordination of national energy planning, programmes, and policy implementation.	In line with this policy, MMFZE is required to abide with optimal energy consumption and environmental sustainability in its operation.
	General Environmental	
Environmental Impact Assessment Act 86 of 1992 (amended by EIA Act CAP E12 LFN 2004) and regulation 2021	This is the primary governing Act for EIA in Nigeria. The Act establishes a procedure and methodology to be followed to undertakean EIA study. Section 2 (2) of the Act requires that an EIA study must be undertaken in accordance with the Act when the extent, nature, or location of the proposed project or activities is likely to affect the environment significantly.	As the proposed Project will entail the construction of a port facility, an ESIA study in line with the provisions of the EIA Act is therefore required prior to the project commencing. Accordingly, an ESIA study is currently being carried out in line with the requirements of this Act and has further considered the Environment Impact Assessment Procedures and Charges Regulation, 2021. MM FZE shall be required to commit to implementing the commitments included in the ESMMP laid out in this ESIA study and any other conditions as laid out by FMEnv, should an ESIA approval be issued for Project.

Governing Documents	Description	Applicability
National Environmental Impact Assessment Procedural and Sectoral Guidelines, 1994	FMEnv developed the National EIA Procedural Guidelines in responseto the establishment of the EIA Act. The Procedural Guidelines assist proponents in conducting detailed E&S assessments by providing an overview of the baseline information, key issues, impacts, mitigation, and management plans to be considered as part of the EIA study.	An ESIA study is currently being undertaken for the Project. This ESIA has been undertaken in compliance with the requirements of these guidelines. MM FZE shall be required to commit to implementing the ESMMP laid out in this ESIA study, and any other conditions stipulated by FMEnv.
The National Environmental (permitting & Licensing System) Regulation, 2009	The purpose of these regulation is to enable consistent application of Environmental Laws, Regulations and Standards in all sectors of the economy and geographical regions.	In line with these regulations, this ESIA study has considered the Environmental Laws, guidelines, standards, and regulations inNigeria during all Project phases.
Waste and Pollution		
National Environmental (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations, 1991, S.I.9	These Regulations impose restrictions on the release of toxic substances into the environment and stipulate requirements for pollution monitoring units, machinery for combating pollution, and contingency plans to be implemented by industries.	The Project, during the construction, operational and decommissioning phases, will generate wastes, which will need to be disposed of as per the guidelines in these Regulations. The ESMMP has considered these regulations and includes a section on the management of both non-hazardous and hazardous wastes.
National Environmental Protection (Effluent Limitation) Regulation 1991, S.I.8	The National Effluent Limitation Regulation, S.1.8 of 1991 (No. 42, Vol.78, August 1991) makes it mandatory for industries such as waste generating facilities (including research institutes, clinics, hotels etc.) to install pollution prevention and pollution abatement equipment on site. The regulation is specific for each category of a waste generating facility with respect to limitations of solid and liquid discharges or gaseous emissions into the ecosystem. Appropriate penalties for contraventions are also specified in the regulation.	The Project, during the construction, operational and decommissioning phases, will generate effluent, which will need to be managed per the guidelines in these Regulations. This regulation requires the Project to install anti-pollution equipment for the detoxification of effluent and chemical discharges emanating from its activities and specify selected wastewater parameters for the industries in the First Schedule to the Regulations.

Governing Documents	Description	Applicability
National Environmental (Management of Solid and Hazardous Wastes) Regulations, 1991, S.I.15	This instrument regulates the collection, treatment, and disposal of solid and hazardous waste streams from municipal and industrial sources. It gives a comprehensive list of chemicals and chemical wasteby toxicity categories. The regulation requires the project proponent to practice waste segregation (at source) and engage the services of a government-approved waste management agents for appropriate waste disposal throughout the project's life cycle.	The Project, during the construction, operational and decommissioning phases, will generate wastes, which will need to be managed and disposed of as per the guidelines in these Regulations. The ESMMP has considered these regulations and includes a section on the management of both non-hazardous and hazardous wastes.
National Environmental (Sanitation and Wastes Control) Regulations, 2009, S.I.28	This Regulation aims to adopt sustainable and environment-friendly practices in environmental sanitation and waste management to minimise pollution.	The provisions included in this Regulation have been considered as part of the Project ESMMP.
National Environmental (Plastic Waste Control) Regulations, 2023.	This Regulation aims to adopt sustainable and environment-friendly practices in reduction of plastic waste and waste management to minimise pollution.	The provisions included in this Regulation have been considered as part of the Project ESMMP.
Soils and Water		
National Environmental (Soil Erosion and Flood Control) Regulations, 2011, S.I.12	The overall objective of this Regulation is to ensure that projects developed on sites that are vulnerable to flooding, including facilities that serve such projects, are protected against flooding by appropriate design at the time of initial construction.	The provisions included in these Regulations will need to be considered by MM FZE as part of Project Engineering designs.
National Environmental (Surface and Groundwater Quality Control) Regulations, 2011, S.I.22	The purpose of these Regulations is to enhance and preserve the physical, chemical, and biological integrity and to maintain existing useof groundwater and surface water resources. The standards contained herein provide for the protection of surface and ground water from pollutants so that the waters shall be protected, used, developed, conserved, managed, and controlled in ways that take into account: ▪ Citizens' right of access to clean water and sanitation. ▪ Protection of aquatic ecosystems and long-term sustainability ofwater resources.	The Project will be associated with waste generation, more specifically solid and effluent wastes, which should be managed and disposed of in an environmentally friendly manner to avoid any form of pollution, including water pollution. This ESIA study and associated ESMMP have considered these regulations.

Governing Documents	Description	Applicability
	■ Reduction and prevention of pollution and degradation of surface water resources and recognition of preventive, precautionary, and polluter-pays-principles.	
Water Resources Act, CAP W2 LFN, 2004	This Act is aimed at promoting the optimum planning, development,and use of Nigeria's water resources; ensuring the coordination of activities that are likely to influence the quality, quantity; distribution, use, and management of water; providing the application of appropriate standards and techniques for the investigation, use, control, protection,and management of water resources; and facilitating technical assistance and rehabilitation for water supplies.	In line with the requirements of this Act, MM FZE will need to safeguard the integrity of water systems within and surrounding the Project area throughout the implementation of the Project. This includes implementing proper waste management to prevent water pollution during the construction, operational and decommissioning phases.
	Climate Change	
Climate Change Act, 2021	The Climate Change Act provides a legal and institutional framework for reducing GHG emissions in Nigeria. The objective of the law is to establish a framework for reducing GHG emissions and to embed climate change actions into national plans and programmes. The Act establishes the National Council on Climate Change (NCCC), which has been delegated the authority to make policies and decisions on all matters relating to climate change in Nigeria. The NCCC is directed to collaborate with the Federal Inland Revenue Service (FIRS) to develop a carbon tax in Nigeria. The proceeds from the carbon tax will go to the Climate Change Fund established under the Act. The Fund is to be used for the administration and general operation of the NCCC, the funding of innovative climate change mitigation and adaptation projects, conducting assessments of climate change impacts on vulnerable communities, and incentivizing the transition to clean energy. The law is the first stand-alone comprehensive climate change legislation in West Africa. The Climate Change Act seeks to achieve net-zero GHG emissions in Nigeria between 2050 and 2070. It further provides a framework to help achieve Nigeria's NDCs and mandates the	In line with the requirements of this Act, this ESIA study has considered the climate change adaptation requirements for the Project and management relating to GHG emissions during all Project phases.

Governing Documents	Description	Applicability
	Ministry of Environment, in consultation with the Federal Ministry for Budget and National Planning, to set a carbon budget to keep the average increase in global temperature to within 2°C, and to help keep to 1.5°C rise above pre- industrial levels. The Act also requires the NCCC to collaborate with the FIRS to develop and implement a mechanism for carbon emission trading and empowers the Ministries to periodically revise the carbon budget, in line with Nigeria's NDCs with a view to complying with Nigeria's international obligations. The Climate Change Act also requires the preparation of a National Climate Change Action Plan (every five-years) to ensure that the carbon budgets are being met, and that climate change mitigation actions are identified and are being actively applied.	
Air Quality		
National Environmental (Air Quality and Control) Regulations, 2021, S.I.88	The objective of the Regulations is for the prevention, control, and reduction of air pollution to ensure clean and healthy ambient air. It provides for the establishment of emission standards for various sources such as mobile sources (e.g., vessels, motor vehicles) and stationary sources (e.g., industries). Emission limits for different areas and facilities have been set. The regulations make provision for designating controlled areas and the setting of objectives of air quality management plans for these areas.	The Project, during the construction, operational and decommissioning phases, will generate air emissions. As part of this ESIA process, a qualitative air quality study has been undertaken. The primary objective of the air quality study is to consider and assess the potential impacts which the Project may have upon existing air quality, during both construction and operational phases. The assessment of key Project emission sources such as: handling, storage and ship loading of granular urea, handling, storage, and ship loading of liquid ammonia, and provision of a flare for disposal of ammonia in the event of overpressure and Gas fired power generation plant (<3MW). Dispersion modelling for the flare stack has been undertaken. The impacts of emissions on air quality have been assessed by comparison of the predicted maximum concentrations with the relevant air quality standards, with reference to the existing baseline conditions. Where required, mitigation has been recommended, noting that some mitigation is already embedded in the project design.

Governing Documents	Description	Applicability
	Noise	
National Environmental (Noise Standards and Control) Regulations, 2009, S.I.35	The Regulation highlights the permissible noise levels to which a person may be exposed, control and mitigate noise, permits for noise emissions above acceptable levels and enforcement maximum permissible noise levels a facility or activity to which a person may be exposed to.	The Project, during the construction, operational and decommissioning phases, will generate noise. As part of this ESIA process, a qualitative noise study has been undertaken. The study has considered noise emissions at the potentially most affected noise sensitive receiver (NSR) locations in proximity to the Project. The Project will be required to comply with these Regulations to promotea healthy and safe working environment throughout all Project phases. Given the fact that all noise sensitive receptors are located at distances greater than 1 km away from the Project boundary, ERM have qualitatively assessed impacts from construction and operational activities. Moreover, a qualitative noise assessment has been undertaken for underwater noise.
	Biodiversity	
National Environmental (Control of Alien and Invasive Species) Regulations, 2013, S.I.32	This regulation seeks to prevent the decline and minimise the modification and destruction of the ecosystem and human health caused by alien and invasive species.	This ESIA study and associated ESMMP have considered a range of potential ecological impacts associated with the Project, including the control of invasive alien plants in the immediate Project area and surrounds and provided the mitigation measures.
Endangered Species Act CAP E9 LFN, 2004 as amended 2016	This Act prohibits, except under a valid license, the hunting, capture, or trade-in animal species, either presently or likely being in danger of extinction, and defines the liability of any offender under this Act. It alsoprovides for regulations to be made necessary for environmental prevention and control regarding the purposes of this Act.	These regulations have been considered in the biodiversity study for this ESIA study and associated ESMMP.
	Health and Safety and Labour	
Employment Laws and Regulations Nigeria 2023	The Employment Laws and Regulation 2023 strengthens employment laws as stated in the constitution of the Federal Republic 1999, the Labour Act 2004, Federal and State laws	MM FZE will be bound to abide to Nigeria labour and employment lawsand regulation during its Project lifecycle.

Governing Documents	Description	Applicability
	that relate to labour and employment, and international conventions, treaties and protocols relating to labour and employment, industrial relations or matters connected therewith that have been ratified by Nigeria.	
Factories Act, CAP F1 LFN 2004	The Factories Act 1990 (amended in 2004) is the primary law regulating the health, safety and welfare of workers in the country's factories. The Law holds management and staff personally responsiblefor violations of the provisions in the Act.	The safety, health, and welfare of all the workers associated with the Project will need to be addressed in line with all the provisions of this Act throughout the Project lifecycle.
Labour Act, CAP L1 LFN 2004	Nigeria has ratified all core International Labour Organisation Conventions. The Labour Act 1990 (amended in 2004) is the primary law protecting the employment rights of individual workers. The Act covers protection of wages, contracts, employment terms and conditions, and recruitment; and classifies types of workers and special workers.	MM FZE will be bound by this Act to abide to its stipulation on employee management and remuneration during its constructionand operational phases.
Trade Unions Act, 2005	This Act contains provisions with respect to the formation, registration, and organization of trade unions. It includes stipulation of 'equal pay for equal workers without discrimination on account of sex, or any other ground whatsoever'.	MM FZE will respect workers' rights to join (or not join) unions of their choice and to engage with those unions, which workers are members of in relation to collective bargaining, disciplinary proceedings, and retrenchment of workers.
National Minimum Wage Act, 2019	The Act prescribes the national minimum wage and provides for a legal framework for a seamless review of the stated national wage.	MM FZE will abide to the stipulation of this Act on employee remuneration during the Project lifecycle.
Employee Compensation Act, 2010	This Act repeals the Workmen's Compensation Act W6 LFN 2004 and makes comprehensive provisions for payment of compensation to employees that suffer from occupational diseases or suffer injuries from accident at workplace or in the course of the employment.	The safety, health, and welfare of all the workers associated with the Project will need to be addressed in line with all the provisions of this Act throughout the Project lifecycle.
Pension Reform Act, 2014	This Act makes provision for the contributory pension scheme for public and private sectors in Nigeria.	MM FZE will be bound by this Act to abide to its stipulation on employee remuneration during all Project phases.
Violence against Persons (Prohibition) Act, 2005	The Violence against Persons (Prohibition) Act (VAPP) was passed into law in May 2015. The Act was necessitated as a	The safety, health, and welfare of all the workers and communities associated with the Project will need to

Governing Documents	Description	Applicability
	result of agitations for the protection of persons against different forms of violence. The Act has strengthened advocacy against rape, female genital mutilation, partner battery, stalking, harmful widowhood practices while prohibiting all forms of violence, including physical, sexual, psychological, domestic, harmful traditional practices and discrimination against persons. It also provides maximum protection and effective remedies for victims and punishment of offenders.	be addressed in line with allthe provisions of this Act throughout the Project lifecycle.
Land		
Land Use Act CAP L5 LFN, 2004	Land Use Act No. 6 was enacted in 1978 (revised in 1990 and 2004). The Act vests all land in the territory of each State (except land vested in the Federal Government or its agencies) solely in the Governor of the State, who holds such land in trust for the people and is solely responsible for the allocation of land in all areas, to individual resident in the State and to organizations for residential, agricultural, and commercial purposes.	MM FZE have legally secured rights to the land associated with development of the Project.
Other		
National Environmental (Ozone Layer Protection) Regulations, 2009, S.I.32	This regulation prohibits the use, emission, storage, and disposal of stratospheric ozone-depleting substances (ODS) and articles which contain those substances.	MM FZE will need to ensure that equipment containing ODS's will either not be used on site or, if currently being used, will need to be phased out.
National Environmental (Construction Sector) Regulations (S.I No. 19), 2011	The purpose of these Regulations is to prevent and minimize pollution from construction, decommissioning, and demolition activities applicable to Nigerian projects. It stipulates that new projects in the construction sector shall apply cost-effective, up-to-date, efficient, use best available technology, to minimize pollution to the barest degree practicable.	This ESIA study considers a variety of potential impacts that may result inpollution to the environment during the construction and decommissioning phases of the Project. MM FZE shall be required to commit to implementing the ESMMP laid out in this ESIA study, and any other conditions stipulated by FMEnv.
Harmful Waste (Special Criminal Provisions) Act CAP H1 LFN, 2004	The Harmful Waste (Special Criminal Provisions) Act CAP H1 LFN, 2004 prohibits and declares unlawful activities relating to the purchase, sale, importation, transit, transportation, deposit, and storage of harmful wastes. Appropriate penalties for infringement are prescribed.	The Project is not anticipated to generate any harmful waste. The ESMMP has considered these regulations and includes a section on the management of both non-hazardous and hazardous wastes.

Governing Documents	Description	Applicability
The Standards Organization of Nigeria (SON) ACT NO. 14, 2015	The Standards Organisation of Nigeria was established by Act. No.56 of 1971 which vested it with the authority for: Standards elaboration, Specifications, Quality assurance system of commodities, manufactured industrial and imported products and services generally. The Act No. 14 of 2015 amended the previous SON Act, 2004, and was enacted for the purpose of providing additional functions for the Standards Organisation of Nigeria, increasing penalty for violations;and for related matters.	MM FZE shall be required to commit the quality standards as certifiedby SON throughout its operation.
Nigerian Ports Authority Act, 1999	Act No.38 of 1999 established the Nigerian Ports Authority with the function of providing and operating necessary facilities in ports and maintaining, improving, and regulating the use of the ports. The Ports Authority has the power to make by-laws that include setting up pollution control guidelines and monitoring oil spillage, dumping of waste and garbage by ships arriving at the ports, wharves, and jetties.	MM FZE will be required to abide to all by-laws set by the Authority relating to operation of the jetty.
National Inland Waterway Authority Act 2016	The Act provides for the establishment of the National Inland Waterways Authority, which handles the development and operations of the National Inland Waterways. One of the Act’s key objectives is to increase and promote private sector investment and participation in the management and operation of the National Inland Waterways Authority assets.	MM FZE will ensure all its vessels that enter or approach the waterways have the requisite authorization or permit to avoid being held liable to a fine not less than N200,000 or imprisonment not exceeding 3 years or both.
Nigerian Maritime Administration and Safety Agency (NIMASA) Regulations 2014	The Act applies to all persons engaged in Stevedoring[2] work including dock labour employers and private operators of any work location (including ports, jetties, onshore and offshore oil and gas or bonded terminals, Inland Container Depots (ICDs) and platforms) within the Nigerian Exclusive Zone.	MM FZE will ensure that it is registered by the Agency and employs only Stevedores or dock workers that are registered and certified by the Agency.
Investment Procedures, Regulations and Operational Guidelines for Free Zones in Nigeria, 2004	The Regulations guide the application for undertaking approved activities in the free zone. The approval process requires submission of a Project description, market survey, funding proposals, five-year financial projections, and Environmental Impact Statement (EIS).	MM FZE is developing the Project ESIA as required, as part of the requirements for application for approval to the Authority.

[2] The process of loading or discharging/ offloading of a ship or cargo to/from a ship.

Governing Documents	Description	Applicability
Nigeria Export Processing Zones Act No 63 of 1992	The Authority functions include the approval of development plans of the Authority and the Zones' annual budgets in respect of infrastructures, administrative buildings, promotion of Zones, the provision and maintenance of services and facilities and the resolution of trade disputes between employers and employees in the Zone, in consultation with the Federal Ministry of Employment, Labour and Productivity	MM FZE will refer its disputes to the authority where the terminal construction/operational activities conflicts with other users.
Onne Oil and Gas Free Zone Authority Act No. 8 of 1996	The Act established the Oil and Gas Export Free Zone Authority. The Act confers the following functions and responsibilities among others to the Authority: • The administration of the Authority and management of the Export Free Zone • The grant of all requisite permits and licenses to conduct approved enterprises within the Export Free Zone; and • The approval of development plans of the Authority and the Export Free Zone, the annual budgets in respect of infrastructures, administrative buildings	MM FZE will be required to obtain all requisite permits and licences to conduct approved enterprises within the Export Free Zone
Criminal Code of 1990 (now CAP 38 LFN, 2004)	The Act contains the primary criminal law offences related to environmental damage, public health, and natural resources. Some environmental crimes include causing a public nuisance, fouling the water of any spring, stream, well, or reservoir of a place, and violating the atmosphere in any position to make it harmful to the health of persons.	MM FZE shall be required to commit to implementing the ESMMP laidout in this ESIA study, and any other conditions stipulated by FMEnv.
Local Content Act 2010	The Nigerian Oil and Gas Industry Content Development Act 2010 (the “Local Content Act”) governs Nigerian content matters in the Nigerian oil and gas industry (the “Industry”). The Local Content Act provides that Nigerian content must be mandatorily considered as a key element of project development in the industry.	Oil & Gas industries have obligations to promote local content, however MMFZE is not an oil & gas company and hence not applicable.
Natural Resources Conservation Act Cap 286 LFN 2004,	This Act established the Natural Resources Conservation Council to be responsible for the conservation of natural resources in Nigeria and formulate national policy for natural conservation.	MM FZE shall be required to commit to implementing the ESMMP laidout in this ESIA study, and any other conditions stipulated by FMEnv.

Governing Documents	Description	Applicability
	Section 3 of the Act provides that the functions of the council shall be to: (a) Coordinate matters concerning the conservation of natural resources in Nigeria; (b) Formulate a national policy for natural resources conservation; (c) To carry out such other activities calculated to facilitate the effectiveness of the performance of the functions of the council under this Act as in Section 3(e). Moreover, the Act, in collaboration with other agencies, controls coastal zone development to minimize erosion on the national coastline. As contained in Section 4(e) of the Act, it also designates sites and species of conservation interest as in Section 4(a).	
National Guidelines for Environmental Audit 1999	National Guidelines for Environmental Audit 1999 provide the framework for Environment Audit in every three years and submit to FMEnv for review and approval.	MM FZE shall be required to commit to implementing the ESMMP laidout in this ESIA study, and the Environmental Audit is captured in EMP.
National Guidelines on Environmental Management System 1999	National Guidelines on Environmental Management System 1999 indicate that the ESMP should be in line with the established guidelines.	MM FZE project ESMMP developed following these guidelines and international best practices.
Nigeria's National Health 2014 Act 2014 (NHA)	Nigeria's National Health Act 2014 (NHA 2014) was signed into law on October 31, 2014. It provides a legal framework for the regulation, development, and management of Nigeria's Health System.	MM FZE project will have a Site Clinic and referrals to take care of health aspect.
Nigeria Nationally Determined Contribution (NDC), 2016 as revised in 2022.	Nigeria's Nationally Determined Contribution (NDC) shows its global commitment towards embracing sustainable development measures that limit the rate of global warming and negative impacts of climate change. It shows the country's climate targets and measures to be adopted in actualizing them. This Guide provides a simplified summary of Nigeria's NDC -- primarily for off-grid renewable energy stakeholders. It provides a context to the NDC, key aspects, summary of targets, mitigation and adaptation measures, key stakeholders, strategy, and update on current implementation status	MM FZE project will have power generation by using compressed natural gas and energy efficient equipment to reduce GHG emissions.

1.7.3 Relevant State Laws and Administrative Institutions

Section 20 of the 1999 constitution of the Federal Republic of Nigeria, states that, "The State shall protect and improve the environment and safeguard the water, air and land, forest and wildlife of Nigeria". Furthermore, the EIA Act No. 86 of 1992 recommends the setting up of state environmental agencies to support the efforts of the FMEnv in regulating the consequences of project development on their environment.

1.7.3.1 Rivers State Ministry of Environment

Since the inauguration of the present democratic administration, Rivers State Government has established a full-fledged Ministry of Environment (RSMENV) headed by a commissioner. The Ministry was created from the Rivers State Environmental Protection Agency (RSEPA). RSMENV was empowered by the decree that set up the repealed FEPA (Decree 58 of 1988, as amended by Decree 59 of 1992), which encourages State governments to set up their own Environmental Protection Agencies. Consequently, RSMENV is charged with the protection of the environment of Rivers State and operates with Edict No. 2 of 1994. In 2002, RSMENV published the Interim Guidelines and Standards on Environmental Pollution Control and Management in Rivers State which was revised in 2013. The guidelines seek to:

- Regulate the generation, handling, storage, disposal, and management of all wastes of whatever origin in Rivers State.
- Regulate physical development in compliance with the principle of sustainable development.
- Enhance and where possible, restore the quality of the environment and protect the biodiversity of the flora and fauna of Rivers State.

1.7.3.2 Rivers State Waste Management Agency (RIWAMA)

The Rivers State Waste Management Agency (RIWAMA) is responsible for the enhancement of the environment but is also mandated to positively change the living conditions and reduce diseases and health problems in the state. It was created in 2013 by the Rivers State House of Assembly and was assented by the state governor in July 2014. Prior to this, the agency functioned as the "Rivers State Environmental Sanitation Authority (RSESA)".

1.7.3.3 Rivers State Noise Control Edict, No. 20, 1985

The law targets reducing occupational noise exposure of workers to noise from factories/industrial machines and exposure of the neighbouring population to noise from nearby factories. It also sets limits for other sources of noise including aircrafts, loud music and public address systems and recommends daily noise exposure limits for industry workers and communities.

1.7.3.4 Rivers State Environmental Protection and Management Law, CAP A42, 2019

The objective of law is to exploit, develop and manage resources to achieve a higher quality of life by ensuring sustainable development. The law prescribing and listing activities that require environmental permits both in manufacturing and non-manufacturing sectors. The law also specifies terms for registration of environmental consultants in the state and conditions for issuance or renewal of the accreditation certificates / permits.

1.7.4 International Conventions, Protocols and Agreements

Nigeria is a signatory to several international conventions and agreements as shown in Table 1-2 targeted toward the conservation and protection of the environment to ensure sustainable development.

Table 1-2: International Conventions, Protocols and Agreements

Conventions	Year Adopted	Overview
The Paris Accord	2015	The Paris Accord is a legally binding international treaty on climate change. It was adopted by 196 Parties at the United Nations Climate Change Conference, COP 21 in Paris, on 12 December 2015 and entered into force on 4 November 2016. The Paris Accord's long-term temperature goal is to keep the rise in mean global temperature to well below 2 °C (3.6 °F) above pre-industrial levels, andpreferably limit the increase to 1.5 °C (2.7 °F), recognizing that this would substantially reduce theimpacts of climate change. Emissions should be reduced as soon as possible and reach net-zero inthe second half of the 21st century. It aims to increase the ability of parties to adapt to climate change impacts and mobilize sufficient finance. Under the Agreement, each country must determine, plan, and regularly report on itscontributions.
International Health Regulations(IHR)	2005	The IHR is an international legal instrument that is binding on 196 countries across the globe, including all the Member States of World Health Organisation (WHO). This binding instrument of international law was first adopted in 1969, revisedin 2005 and entered into force on 15 June 2007. The purpose and scope are "to prevent, protect against, control and provide a public health response to the international spread of disease in ways that are commensurate with and restricted topublic health risks and which avoid unnecessary interference with international traffic and trade".
International Labour Organization (ILO): ILO-OSH, 2001 - Guidelines on Occupational Safety and Health (OSH) Management	2001	These guidelines call for coherent policies to protect workers from occupational hazards and risks while improving productivity. The guidelines present practical approaches and tools for assisting organizations, competent national institutions, employers, workers, and other social partners in establishing, implementing, and improving occupational safety and health management systems, with the aim of reducing work-related injuries, ill health, diseases, incidents, and deaths. At the organizational level, the guidelines encourage the integration of OSH management system elements as an important component of overall policy and management arrangements. Organizations, employers, owners, managerial staff, workers, and their representatives

Conventions	Year Adopted	Overview
		are motivated in applying appropriate OSH management principles and methods to improve OSH performance. Nigeria ratified the guidelines in 2001.
The United Nations Conventionon Biological Diversity	1994	The Convention was adopted in 1994. The objectives of the Convention include the conservation of biological diversity, the sustainableuse of its components and the fair and equitable sharing of benefits arising out of the utilization of genetic resources.
The Rio Declaration on Environment and Development	1992	The Declaration was made in 1992 in Rio de Janeiro, reaffirming the declaration of the United Nations Conference on Human Environment adopted at Stockholm in 1972. The principle workstowards international agreement which respects the interest of all and protects the integrity of the global environment and development. The principles of the declaration relevant to the proposed project include: <u>Principle 4</u>: To achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation fromit. <u>Principle 17</u>: EIA as a national instrument shall be undertaken for proposed activities that are likely tohave a significant adverse impact on the environment and are subject to a decision of a competent national authority.
The United Nations Framework Convention on Climate Change	1992	The Convention on Climate Change was adoptedin 1992 during the Rio Earth Summit in Rio De Janeiro, Brazil and entered into force in 1994 to limit Greenhouse Gas (GHG) emissions which cause global warming.
International Convention on Oil Pollution Preparedness, Response, and Co-operation (OPRC)	1990	Parties to the International Convention on OPRC are required to establish measures for dealing withpollution incidents, either nationally or in co- operation with other countries. Parties to the convention are required to provide assistance to others in the event of a pollution emergency andprovision is made for the reimbursement of any assistance provided. Ships and operators are required to carry a shipboard oil pollution emergency plan, oil pollutionemergency plans or similar arrangements which must be coordinated with national systems for responding promptly and effectively to oil pollution incidents.
The Montreal Protocol on Substances that deplete the Ozone Layer. Adopted on September 16, 1987.	1987	The Protocol was adopted on 16 September 1987as an international treaty to eliminate ozone depleting chemicals production and consumption.
Vienna Convention for the Protection of the Ozone Layer.	1985	The Vienna Convention was adopted in 1985 and entered into force on 22 September 1988. It placesgeneral obligations on countries to make appropriate measures to protect the environment against adverse effects resulting from human activities which tend to modify the ozone layer.
Protocol Concerning Cooperation in	1981	The objective of the protocol is to protect the marine environment, the coastal zones and the related internal waters falling within the jurisdictionof the States of the West and Central African region against

Conventions	Year Adopted	Overview
Combating Pollution in Cases of Emergency in the West and Central African Region		pollution in cases of emergency. The Parties undertake to cooperate in all matters relating to the protection of their respective coastline and related interests from the threat andeffects of pollution resulting from marine emergencies, especially by exchanging relevant information (arts. 4, 5, 6, 7, 8 and 10). They agreeto assist each other, on demand, in cases of marine emergencies (art. 8). Finally, they are to endeavor to maintain and promote marine emergency contingency plans (art. 9) and take appropriate measures to prevent, reduce, combat, and control the effects of pollution (art. 10).
Convention on the Conservationof Migratory Species of Wild Animals, 1979	1979	This Convention, also known as the Bonn Convention, was adopted in 1979 and entered intoforce in 1983. It stipulates actions for the conservation and management of migratory species including habitat conservation. <u>West African Aquatic Mammals Memorandum ofUnderstanding (MoU), 2008</u> This MoU concerns the conservation of the manatees and small cetaceans of Western Africa and Macaronesia. It is a Multilateral Environmental MoU and entered into effect on 3 October 2008 under the auspices of the Convention on the Conservation of Migratory Species of Wild Animals. The MoU aims to protectthese species at a national, regional, and global level. <u>MoU concerning Conservation Measures forMarine Turtles of the Atlantic Coast</u> This MoU requires signatories to endeavor to put in place measures for the conservation and, where necessary and appropriate, strict protection of marine turtles at all stages of their life cycle (including eggs, hatchlings, juveniles, sub-adults, and adults. It came into effect in 1999 and is an agreement under Article IV, paragraph 4, of the Convention on the Conservation of Migratory Species of Wild Animals.
African Convention on the Conservation of Nature and Natural Resources	1968	The African Convention on the Conservation of Nature and Natural Resources was adopted in Algiers, Algeria, on 15 September 1968, and entered into force on 16 June 1969. The Convention stipulates that the contracting States shall undertake to adopt the measures necessary to ensure conservation, utilization and developmentof soil, water, flora, and fauna resources in accordance with scientific principles and with due regard to the best interests of the people.
Ramsar Convention on wetlands	1971	The Ramsar Convention on Wetlands of International Importance, especially as Waterfowl Habitat is an international treaty for the conservation and sustainable use of Ramsar sites (wetlands). Every three years, representatives of the contracting parties meet as the Conference of the Contracting Parties (COP), the policy-making organ of the convention which adopts decisions (site designations, resolutions and recommendations) to administer the work of the convention and improve the way in which the parties are able to implement its objectives of conservation of the Ramsar wetlands of international importance.

Systematic compliance of the above international conventions, protocol, and agreement will ensure the MM FZE operates sustainably.

1.7.5 International Best Practice Standards and Guidelines

1.7.5.1 Equator Principles (EPIV)

The Equator Principles provide a set of ten principles of voluntary standards that present a credit risk management framework for determining, assessing, and managing social and environmental risk in project financing. The Equator Principles are based on the IFC PSs on social and environmental sustainability and on the World Bank Group EHS Guidelines. The Project has committed to complying with this set of principles, which together with the IFC PSs and the EHS Guidelines will be used as a benchmark for IBP. Details of the applicability of the Equator principles to the Project ESIA process are provided in Table 1-3 below.

Table 1-3: Applicability of the Equator Principles to the Project Environmental and Social Impact Assessment Process

Principle	Relevance to Project
Review and Categorization	Category A project.
Social and Environmental Assessment	MM FZE is currently undertaking an internationally compliant ESIA study for the Project.
Applicable Social and Environmental Standards	The ESIA study and associated ESMMP has been undertaken inaccordance with standards and recommendations of IFC Performance Standards and EHS Guidelines.
Action Plan and Management System	At this stage, MM FZE has a number of environmental, social, occupational health and safety and human resource plans, policies and procedures. These plans, policies and procedures relate to all Indorama's operations in Port Harcourt. Over the life of all of MM FZE's operations, the vehicle by which the commitments set out in the ESMMP related to this ESIA study and other plans, policies and procedures should be developed into specific actions, which can beimplemented through an overarching Environmental and Social Management System (ESMS).
Consultation and Disclosure	On-going stakeholder engagement, community consultation and disclosure were undertaken under the platform of the FMEnv for 21 working days at Federal, State and LG level and was advertise in two national daily's and was augmented with radio announcement for the 1st and last 5days of the display period in the state radio. Detailed stakeholder engagement and Stakeholder Engagement Plan (SEP) have been developed as part of this ESIA study.
Grievance Mechanism	A Project's Grievance Mechanism will be developed as part of SEP.
Independent Review	The Project lenders will need to appoint an independent review panel to review all Project documentation.
Covenants	Relevant Nigerian legislation is being complied with MM FZE employees and activities will need to comply withcommitments included in the ESMMP. Annual reports will need to be prepared documenting actions and activities demonstrating these commitments.
Independent Monitoring and Reporting	The Project lenders will need to appoint an independent review panel to review all Project documentation.
Equator Principle Founding Institute (EPFI) Reporting	This will not be MM FZE's responsibility.

1.7.5.2 *International Finance Corporation Performance Standards on Environmental and Social Sustainability, 2012 (IFC PSs)*

IFC's Sustainability Framework (International Finance Corporation, World Bank Group) articulates the Corporation's strategic commitment to sustainable development and is an integral part of IFC's approach to risk management. The Sustainability Framework comprises IFC's Policy and PSs on Environmental and Social Sustainability, and IFC's Access to Information Policy.

The Policy on Environmental and Social Sustainability describes IFC's commitments, roles, and responsibilities related to environmental and social sustainability. IFC's Access to Information Policy reflects IFC's commitment to transparency and good governance on its operations and outlines the Corporation's institutional disclosure obligations regarding its investment and advisory services.

The PSs are directed towards clients, providing guidance on how to identify risks and impacts, and are designed to help avoid, mitigate, and manage risks and impacts as a way of doing business in a sustainable way, including stakeholder engagement and disclosure obligations of the client in relation to project-level activities.

IFC requires its clients to apply the PSs to manage E&S risks and impacts so that development opportunities are enhanced. Table 1-4 below provides an overview of how the Project relates to IFC PSs.

Table 1-4: International Finance Corporation Performance Standards

Performance Standards	Key Requirement	Relevance to the Project
IFC PS1: Assessment and Management of Environmental and Social Risks and Impacts	This PS relates to integrating and managing E&S performance throughout the life of a project in linewith national regulations and international standards. The standard requires the development of an Environmental and Social Management System (ESMS) that entails a structured approach to managing environmental and social risks and impacts. Moreover, the PS describes how E&S issues are tobe handled in project development and serves as the core around which the other standards are framed. This standard requires that nearby communities be appropriately engaged on issues that could potentially affect them. Key requirements include: ■ Conducting an informed consultation and participation process with affected communities.	The Project poses a number of E&S risks and impacts, which will need tobe appropriately managed. Appropriate management measures have been included in the ESMMP. Moreover, as part of the ESIA process stakeholder consultation will be continuous both during the ESIA process and post-ESIA. At this stage Indorama have several environmental, social, occupational health and safety and human resource plans, policies and procedures that relate to all MM FZE's operations in Port Harcourt. Over the life of all of MM FZE's operations, the vehicle by which the commitments set out in the ESMMP related to this ESIA study and other plans, policies and procedures should be developed into specific actions which can be implemented through an

Performance Standards	Key Requirement	Relevance to the Project
	▪ Working in an inclusive and culturally appropriate manner. ▪ Addressing the needs of disadvantaged or vulnerable groups; and ▪ Making available an effective grievance management system.	overarching Environmental and Social Management System (ESMS).
IFC PS2: Labour and Working Conditions	This standard aims to ensure that the Proponent establishes, maintains, and improves a worker- management relationship that promotes the fair treatment, non-discrimination and equal opportunity of workers, and compliance with national labour and employment laws and international standards (as defined by the International Labour Organisation (ILO). In particular, PS2 addresses child labour and forced labour, and promotes safe and healthy working conditions, and protecting and promoting the health of workers by recognizing the role of employees.	Project workers (for all Project phases) will need to be providedwith fair labour and working conditions. This will apply to all categories of workers irrespective of whether directly engaged by MM FZE or Contractor (direct workers), engaged through third parties (contracted workers), and workers engaged by the client's primary suppliers (supply chain).
IFC PS 3: Resource Efficiency and Pollution Preventions	This PS aims to abate pollution to air, water, and land that may threaten people and the environment at the local, regional, and global levels. This PS promotes the ability of private sector companies to adopt such technologies and practices where feasible.	Development of the Project will require several resources, which have the potential to causesome negative E&S impacts. All required resources will need to be used efficiently and all wastes managed in accordance with the waste management hierarchy, where avoidance of waste generation is the priority.
IFC PS 4: Community, Health, Safety and Security	The role of this PS is to anticipate and avoid adverse impacts on the health and safety of the affected communities throughout the life of the project because of routine and non-routine events. The PS also requires an assessment of how use of security by the project to safeguard personnel and property could impact on communitysecurity considering considerations of human rights.	Implementation of the Project will need to ensure that the health, safety, and security of all Project affected communities are not compromised.
IFC PS5: Land Acquisition and Involuntary Resettlement	PS5 refers to the management of physical and economic displacement resulting from project-related land acquisition through resettlement and livelihood restoration processes. Objectives are to: ▪ Avoid, and when avoidance is not possible, minimize displacement by exploring alternative project designs.	MM FZE have legally secured rights to the land associated with development of the Project. There will be no resettlement required for this land. The securing of land and access restrictions to surrounding communities will need be in line withthe requirements of PS5.

Performance Standards	Key Requirement	Relevance to the Project
	■ Avoid forced eviction. ■ Anticipate and avoid, or where avoidance is not possible, minimize adverse social and economic impacts from land acquisition or restrictions on land use by: - Providing compensation for loss of assets at replacement cost. - Ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected. - Improve, or restore, the livelihoods and standards of living of displaced persons. - Improve living conditions among physically displaced persons through the provision of adequate housing with security of tenure at resettlement sites.	
IFC PS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	This PS aims to protect and conserve biodiversity based on the Convention on Biological Diversity. It divides habitat into three categories, modified, natural, and critical. For projects in natural habitat, mitigation measures should be designed to achieve no net loss of biodiversity where feasible. For projects in critical habitats, the project's mitigation strategy should be described in a Biodiversity Action Plan and be designed to achieve net gains of those biodiversity values for which the critical habitat was designated.	Assessment of the proposed Project's impacts on biodiversity hasbeen carried out in line with the requirements of this PS.
IFC PS7: Indigenous Peoples	This PS deals with safeguarding Indigenous Peoples. The aim of this PS is to protect the interests of Indigenous Peoples (IPs) during projectimplementation. On a broader scale, it requires project implementation to avoid adverse impacts onIndigenous Peoples as well as ensuring their participation and consent.	No recognized IPs are impacted by this Project, hence PS7 is not triggered.
IFC PS8: Cultural Heritage	Cultural heritage, according to this PS, refers to tangible forms of cultural heritage, such as tangible movable or immovable objects, property, sites, structures, or groups of	As part of this ESIA process a cultural heritage impact assessment (considering both tangible and intangible forms of cultural heritage)

Performance Standards	Key Requirement	Relevance to the Project
	structures, having archaeological (prehistoric), paleontological, historical, cultural, artistic, and religious values; unique natural features or tangible objects that embody cultural values, such as sacred groves, rocks, lakes, and waterfalls; and certain instances of intangible forms of culture that are proposed to be used for commercial purposes, such as cultural knowledge, innovations, and practices of communities embodying traditional lifestyles.	has been included.

1.7.5.3 The World Bank Group (WBG) Environmental, Health and Safety (EHS) Guidelines.

The World Bank Group (WBG) Environmental, Health and Safety (EHS) Guidelines (2007) are a set of technical reference materials that provide pollution related limits and standards. Generally, the Guidelines seek to avoid, minimize and control environmental, health and safety (EHS) impacts during the construction, operation and decommissioning phase of a project or facility and are applicable to this Project. The EHS Guidelines serve as a technical reference source to support the implementation of the IFC PSs.

General EHS Guidelines exist, which contain information on cross-cutting EHS issues potentially applicable to all industry sectors; these are listed in Table 1-5 below.

Table 1-5: IFC General EHS Guidelines

General EHS Guidelines
1. Environmental
1.1 Air Emissions and Ambient Air Quality
1.2 Energy Conservation
1.3 Wastewater and Ambient Water Quality
1.4 Water Conservation
1.5 Hazardous Materials Management
1.6 Waste Management
1.7 Noise
1.8 Contaminated Land
2. Occupational Health and Safety
2.1 General Facility Design and Operation
2.2 Communication and Training
2.3 Physical Hazards
2.4 Chemical Hazards
2.5 Biological Hazards
2.6 Radiological Hazards
2.7 Personal Protective Equipment (PPE)
2.8 Special Hazard Environments

2.9 Monitoring

3. Community Health and Safety
3.1 Water Quality and Availability
3.2 Structural Safety of Project Infrastructure
3.3 Life and Fire Safety (L&FS)
3.4 Traffic Safety
3.5 Transport of Hazardous Materials
3.6 Disease Prevention
3.7 Emergency Preparedness and Response

4. Construction and Decommissioning
4.1 Environment
4.2 Occupational Health and Safety
3. Community Health and Safety

Where applicable, the above-mentioned EHS Guidelines will be considered in this ESIA process; however, the Air Emission and Ambient Air Quality Guideline (1.1); the Wastewater and Ambient Water Quality Guideline (1.3); the Water Conservation Guideline (1.4); and the Noise Guideline (1.7) are of particular importance to the proposed ESIA process. These are discussed in more detail in the Sections below.

1.7.5.3.1 IFC EHS Guidelines – 1.1 Air Emissions and Ambient Air Quality

The IFC recommend that the air quality guidelines as set out by the World Health Organisation (WHO) be utilised in such an assessment. The WHO standards are divided into a number of stages, which have interim targets and a final guideline target. The WHO guidelines are recognised to be particularly conservative, as they make no consideration of the economic burden of achieving the stipulated guidelines. The WHO final guideline target is aspirational, and as such, this target should be progressively worked towards.

The Nigerian Government has developed a list of environmental standards for the purpose of preventing significant industrial pollution. Nigerian ambient air quality standards are set out in Table 1-6 below.

Table 1-6: Nigerian Air Quality Standards

Pollutant	Averaging Period	Value (µg/m^3)
Nitrogen dioxide (NO2)	Annual	80
	24 hours	120
	1 hour	200
Particulate Matter (PM10)	Annual	60
	24 hours	150
Particulate Matter (PM2.5)	Annual	20
	24 hours	40
Ammonia (NH3)	Annual	200
	24 hours	600

It must be noted that the IFC/WHO do not set guidelines for ammonia and therefore guidelines from the Environment Agency for England (EAE) are suggested. Table 1-7 below provides the WHO/IFC and EAE ambient air quality guidelines for those pollutants included in the Nigerian air quality standards.

Table 1-7: WHO/IFC and EAE Ambient Air Quality Guidelines

Pollutant	Averaging Period	Value (µg/m^3)
NO2	Annual mean	40
	1 Hour Maximum	200
PM10	Annual mean	70 (interim target -1)
	24 Hour, 4th Highest (99th percentile)	150 (interim target-1)
PM2.5	Annual mean	35 (interim target-1)
	24 Hour Maximum	75 (interim target-1)
NH3	Annual Mean	180 [5]
	1 Hour Maximum	2,500 [1]

Taking the above into account, the Project specific guidelines (which consider Nigerian ambient air quality standards and air quality guidelines from the WHO/IFC and EAE) are presented in Table 1-8 below.

Table 1-8: Project Specific Guidelines

Pollutant	Averaging Period	Origin of Guideline	Value (µg/m^3)
NO2	Annual mean	IFC	40
	1 Hour Maximum	IFC	200
PM10	Annual mean	Nigeria	60
	24 Hour Maximum	Nigeria	150
PM2.5	Annual mean	Nigeria	20
	24 Hour Maximum	Nigeria	40
NH3	Annual Mean	EAE	180
	1 Hour Maximum	EAE	2,500

1.7.5.3.2 IFC EHS Guidelines – 1.3 Wastewater and Ambient Water Quality, 2007

IFC EHS Guideline 1.3 specifies that discharges should not result in contaminant concentrations in excess of local ambient water quality criteria or, in the absence of local criteria, other sources of ambient water quality. Receiving water use and assimilative capacity, taking other sources of discharges to the receiving water into consideration, should also influence the acceptable pollution loadings and effluent discharge quality.

The WBG EHS Guideline states that process wastewater should be consistent with the applicable Industry Sector EHS Guidelines and in compliance with national or local standards for wastewater discharge.

1.7.5.3.3 IFC EHS Guidelines – 1.4 Water Conservation, 2007

Mechanisms included in the water conservation guidelines include –

- The setting of targets for water use, and monitoring of water flows against these targets
- Water reuse where possible; and
- Reducing leaks and making more efficient use of water within the water reticulation system.

1.7.5.3.4 IFC EHS Guidelines – 1.7 Noise, 2007

The IFCs EHS Guidelines – *General EHS Guidelines: Environmental Noise Management 1.7 Noise* (IFC 1.7 Noise) is an internationally recognised guideline document containing information for the assessment and management of noise.

Table 1-9 presents the IFC noise guidelines that should not be exceeded at the nearest Noise Sensitive receptor (NSR) locations offsite. These guidelines are generally based on an interpretation of the relevant section of the WHO 1999 guidance concerning the effect of noise on people and implied potential health effects. They are designed to apply to noise emissions from facilities and stationary noise sources (such as factories).

In addition to the absolute values provided in Table 1-11 below, the IFC also requires that noise increase above existing (background) levels should not exceed 3 dB at the nearest receptor location off-site.

Table 1-9: IFC Noise Level Guidelines

Receptor	One Hour LAeq (dB(A))	
	Daytime (07:00 – 22:00)	Night (22:00 – 07:00)
Residential; institutional; educational	55	45
Industrial; commercial	70	70

LAeq = A-weighted equivalent sound levels over a measurement period, dB(A) = A-weighted decibel

IFC noise guidelines give no guidance on construction noise. As such, for the construction phase of the Project specifically, the ESIA process has adopted the Nigerian noise criteria included in the National Environmental (Noise Standards and Control) Regulations, 2009, S.I.35 (refer totable 1-10 below).

Table 1-10: Nigerian Construction Noise Criteria

Receptor	Maximum noise level permitted LAeq dB(A)	
	Day time	Night-time
Hospitals, schools, institutions of higher learning, homes for the disabled, etc.	**60**	50
Buildings other than those prescribed above	**75**	65

Construction activities will take place only during the daytime, therefore the assessment of construction noise is based only on the daytime noise criteria (i.e. – those included in bold in Table 1-10 above).

In addition to construction noise specific criteria, the Nigerian Noise Standards and Control Regulation includes maximum permissible LAeq levels for a range of receptor types. These are presented in Table 1-11 below.

Table 1-11: Maximum Permissible Noise Levels in Nigeria

Receptor	Maximum noise level permitted LAeq dB(A)	
	Day time 06:00 – 22:00	Night-time 22:00 – 06:00
Any building used as hospital, convalescence home, home for the aged, sanatorium and institutes of higher learning, conference rooms, public library, environmental or recreational sites	45	35
Residential buildings	50	35
Mixed residential	55	45
Residential + industry or small-scale production+ commerce	60	50
Industrial (outside perimeter fence)	70	60

The NSRs in the proximity of the Project can be classified as "*residential + industry or small-scale production+ commerce*" according to the Nigerian standards; however, for this ESIA process the more stringent criteria for "*residential, institutional; educational*" receptors as prescribed by the IFC will be used.

As such, for Project activities during the operational phase to create a significant noise impact, the noise generated must be above the noise impact threshold levels, as summarised in Table 1-12 below as well as below to 90 dB(A) in operational area.

Table 1-12: Project Noise Criteria for Operational Phase

Receptor	One Hour LAeq (dB(A))	
	Daytime (06:01 – 22:00)	Night (22:01 – 06:00)
Residential; institutional; educational	55	45

The daytime period will be based on the Nigerian criteria between 06:01 to 22:00 hours and the night-time period will be between 22:01 to 06:00 hours.

1.7.6 AfDB Integrated Safeguards Systems

The AfDB's Integrated Safeguards System (ISS) is a set of policies, procedures, and guidelines established to identify, assess, and mitigate potential E&S risks and impacts associated with the Bank's funded projects and programs. The ISS were designed to ensure that the Bank's investments promote sustainable development and do not harm people or the environment. The updated ISS (April 2023) are comprised of the following:

- AfDB's Vision for Sustainable Development
- AfDB's E&S Policy
- Ten E&S Operational Safeguards (OS)
- E&S Guidance Notes (ISS Guidance notes)

There is a significant overlap between the AfDB operational safeguards and the IFC PSs; nevertheless, as the AfDB safeguards are also relevant to this Project the assessment of E&S performance is also assessed against these. A summary of the AfDB Safeguards is provided in Table 1-13 below

Table 1-13: AfDB Updated Integrated Safeguards System, 2023

AfDB Safeguard	Description	Relevant IFC PS
E&S OS 1 (Assessment and Management of Environmental and Social Risks and Impacts)	The aim of this overarching OS, along with the nine other Oss that complement it, is to mainstream E&S considerations; including those related to climate change vulnerability; into Bank operations and thereby contribute to sustainable development in Africa. An ESIA study carried out under this OS helps to determine the scope and extent to which other OSs are addressed. It sets out the Borrower's (or Project's) responsibilities for assessing, managing, and monitoring E&S risks and impacts associated with each stage of an operation/project supported by AfDB. This OS, together with OS10 (Stakeholder Engagement and Information Disclosure) provide the overall process framework for the E&S assessment and management of AfBD financed operations at project level.	PS1
E&S OS 2 (Labour and Working Conditions	The objectives of OS2 are as follows: protect workers' rights; promote safety and health in the workplace; promote the fair treatment, non-discrimination, and equal opportunity of project workers; protect project workers, including vulnerable workers; prevent the use of all forms of forced labour and child labour; support the principles of freedom of association and collective bargaining of project workers, provide project workers with accessible means to raise workplace concerns; and enquire that the Bank, and national competent authorities as appropriate, be informed promptly of any material adverse impacts and events relating to labour protection and health and safety at the workplace. The applicability of this OS is established during the ESIA described in OS1.	PS2
E&S OS 3 (Resources Efficiency and Pollution Prevention and Management)	OS3 sets out the requirements to address resource efficiency and pollution 36 prevention and Management throughout the project life cycle in a manner consistent with Good International Industry Practice (GIIP). Throughout the different phases of the project's lifecycle—planning and design, construction, commissioning, operations, and decommissioning—the project is required to assess and evaluate resource-efficiency and pollution-prevention techniques and implement them, taking into consideration their technical and financial feasibility and cost-effectiveness. The applicability of this OS is established during the ESIA described in OS1.	PS3
E&S OS 4 (Community Health, Safety and Security)	This OS addresses potential risks and impacts on communities that may be affected by project activities. Occupational health and safety (OHS) requirements for project workers are set out in OS2, and measures to avoid or minimize impacts on human health and the environment due to existing or potential pollution are set out in OS3 . The applicability of this OS is established during the ESIA described in OS1.	PS4

AfDB Safeguard	Description	Relevant IFC PS
E&S OS 5 (Land Acquisition, Restrictions on Access to Land and Land Use, and Involuntary Resettlement)	The objectives of OS5 are to: avoid involuntary resettlement where feasible, or minimize resettlement impacts where involuntary resettlement is deemed unavoidable after all alternative project designs have been explored; ensure resettlement plans and activities are informed by social assessments (including gender issues); avoid forced evictions; mitigate unavoidable adverse social and economic impacts from land acquisition or restrictions on land use; improve living conditions of poor or vulnerable persons who are physically displaced by the project; establish a mechanism for monitoring the performance and effectiveness of involuntary resettlement activities which result from project activities; conceive and execute resettlement activities as sustainable development programs; and ensure that resettlement activities are planned and implemented with appropriate disclosure of information, meaningful consultation, and the informed participation of those affected. The applicability of OS5 is established during the ESIA described in OS1	PS5
E&S OS 6 (Habitat and Biodiversity Conservation & Sustainable Management of Living Natural Resources)	This OS outlines the requirements for the Project to (i) identify and implement opportunities to conserve and sustainably use biodiversity and natural habitats, and (ii) observe, implement, and respond to requirements for the conservation and sustainable management of priority ecosystem services. The applicability of OS6 is established during the ESIA as described in OS1.	PS 6
E&S OS 7 (Vulnerable Groups)	OS7 contributes to poverty reduction and sustainable development by ensuring that projects supported by the Bank enhance opportunities for vulnerable groups to participate in, and benefit from, the development process in ways that do not threaten their unique cultural identities and well-being. The applicability of OS7 is established during the ESIA as described in OS1	PS1
E&S OS 8 (Cultural Heritage)	This OS sets out general provisions on risks and impacts to cultural heritage from project activities. OS7 sets out additional requirements for cultural heritage in the context of vulnerable groups and highly vulnerable rural minorities including Indigenous Peoples (IPs). The applicability of this OS is established during the ESIA described in OS1.	PS8
E&S OS 9 (Financial Intermediaries (FIs))	The objectives of this OS are to: set out how the FI will assess and manage environmental and social risks and impacts associated with the subprojects it finances; promote good environmental and social management practices in the subprojects the FI finances; o promote good environmental and sound human resources management within the FI; support the adoption of best practice standards in corporate governance, business management and corporate responsibility by enterprises supported by the Bank based upon the requirements of OSs 1 through 10, as appropriate; and encourage the consideration of environmental and social governance issues in capital market institutions such as development finance entities and stock exchanges	Interpretation Note on Financial Intermediaries
E&S OS 10 (Stakeholder Engagement and Disclosure of Information)	This OS therefore recognizes the importance of open and transparent engagement between the project and project stakeholders as an essential element of good international practice. Effective stakeholder engagement can improve the environmental and social sustainability of projects, enhance project acceptance, and make a significant contribution to successful project design and implementation. OS10 applies to all Bank Group's funded operations. The project will engage with stakeholders as an integral part of the project's ESIA and project design and implementation, as outlined in OS1	PS 1

1.7.7 Industry Specific EHS Guidelines-Ports, Harbors, and Terminals

In addition to the above General EHS Guidelines, the Guideline for Ports, Harbors and Terminals is also relevant to the Project. The Ports, Harbors and Terminals Guidelines expands on the General EHS Guidelines and includes industry specific management guidance.

The following industry specific guidelines apply to the proposed Project:

Environment

- Air Emissions
- Wastewater
- Hazardous Materials
- Waste management
- Noise
- Biodiversity

Occupational Health and Safety

- Physical Hazards
- Chemical Hazards
- Confined Spaces
- Exposure to Organic and Inorganic Dust
- Exposure to Noise

Community Health and Safety

- Port Marine Safety
- Port Security
- Visual

These are discussed in further detail below.

1.7.7.1 Air Emissions

Air emissions are generated from land- and sea-based sources during terminal activities. The primary air emissions from combustion exhaust sources are sulphur dioxide (SO_2), nitrogen oxides (NO_X), carbon monoxide (CO), particulate matter (PM), and greenhouse gases such as carbon dioxide (CO_2). Others include gaseous inorganic compounds and particulate emissions, especially particulate matter less than 10 microns in aerodynamic diameter (PM_{10}) from prilling.

Non- routine emissions associated with process upsets or accidents may contain natural gas, carbon monoxide (CO), hydrogen (H_2), carbon dioxide (CO_2), volatile organic compounds (VOCs), nitrogen oxide (NO_X), and ammonia (NH_3). Other sources of air emissions include volatile organic compound (VOC) emissions from fuel storage tanks and fuel transfer activities, in addition to dust emissions from construction and operational phase activities (e.g., storage and handling of dry bulk cargo and vehicle traffic on unpaved roads). Apply air quality management procedures for ship operations while in the port areas. These are validating ship engine performance documentation and certification to ensure compliance with consumption emissions specifications, use of low-Sulphur fuels in port, cargo transfer equipment maintenance, reduce engine idling during on- and off-loading. EHS Guidelines for Shipping has specific recommendations to the management of air emissions. The air quality guidelines provided in section1.7.5.3 presented above will be applicable to the project.

1.7.7.2 Wastewater

Wastes originating at the terminal include inert solid waste from cargo packaging and from administrative offices, as well as hazardous or potentially hazardous waste associated with vehicle maintenance operations, such as paint, scrap metal, used lubricating oils and engine degreasing solvents. Wastes originating from ships include oily sludge, inert materials such as food packaging, and food waste. General EHS guidelines are applicable to terminal generated wastes, whether hazardous or non-hazardous and specific pollution prevention, minimisation, and control recommendations for ship generated wastes. Table1-14 presents the Nigerian standards associated with sewerage discharge to the environment and IFC. The most stringent of these guidelines and standards are used for the Project ESIA process.

Table 1-14: The FMEnv limits for Discharged Effluent to the Environment

Parameter(s)	FMEnv Limits (Effluent Discharges)	IFC Guideline applicable to the Project
pH	6.5 – 8.5	6.0 – 9.0
Appearance	-	-
Temperature Increase (oC)	-	<3
Elect. Cond. (µs/cm)	-	-
TDS (mg/l)	2,000	2,000
Turbidity (NTU)	-	-
TSS (mg/l)	30	50
Total Hardness (mg/l)	-	-
Alkalinity (mg/l)	-	-
Chloride, Cl-(mg/l)	600	600
Sulphate, SO42-(mg/l)	500	500
Nitrate, NO3-(mg/l)	20	20
Phosphate, PO43- (mg/l)	5.0	5.0
Cyanide CN- (mg/l)	0.1	0.1
Ammonium NH4+ (mg/l)	5	5
Urea (mg/l)	-	1
Formaldehyde (mg/l)	-	-
Total Nitrogen (mg/l)	-	10
DO (mg/l)	>4.0	>4.0
BOD (mg/l)	30	30
COD (mg/l)	150	125
O & G (mg/l)	10	10
Sodium, Na (mg/l)	-	-
Potassium, K (mg/l)	-	-
Iron, Fe (mg/l)	5.0	5.0
Calcium, Ca (mg/l)	200	200

Parameter(s)	FMEnv Limits (Effluent Discharges)	IFC Guideline applicable to the Project
Magnesium, Mg (mg/l)	200	200
Zinc, Zn (mg/l)	1.0	1.0
Copper, Cu (mg/l)	1.0	1.0
Manganese, Mn (mg/l)	5.0	5.0
Chromium, Cr (mg/l)	1.0	1.0
Silver, Ag (mg/l)	0.1	0.1
Lead, Pb (mg/l)	1.0	1.0
Mercury, Hg (mg/l)	0.05	0.05
Cadmium, Cd (mg/l)	0.1	0.1
Nickel, Ni (mg/l)	1.0	1.0
Arsenic, As (mg/l)	0.1	0.1
Total coliform bacteria (MPN/100ml)	400	400

Terminal facilities should provide adequate means of receiving and managing effluents and wastes to meet the needs of the port and those of visiting ships that the port is designed to service. These includes appropriately sized and located receptacles, and the capacity to deal with seasonal fluctuations of port- and ship-generated wastes.

1.7.7.3 Hazardous Materials

Hazardous materials at terminals typically include large volumes of hazardous cargo, as well as oil, fuels, solvents, lubricants, and other hazardous substances used in terminal activities. Spills may occur due to accidents, equipment failure, or improper operating procedures during cargo transfer or fuelling. The General EHS Guidelines addresses management of the general hazardous materials.

1.7.7.4 Noise

Typical sources of noise emissions include large size rotating machines such as compressors and turbines, pumps, electric motors, air coolers, conveyors belts, fired heaters, and from emergency depressurization. Excessive noise is as a result from typical terminal operations such as cargo handling, vehicular traffic, and loading/unloading of containers and ships. High underwater noise and vibration levels may be generated from several sources, these include offshore pile driving, dredging, and ship traffic, during ports' construction and operational phases. Noise from these activities may adversely impact aquatic habitats and the health and behaviours of aquatic life. The General EHS Guidelines provides guidance on noise management, setbacks, and acceptable noise levels. The noise guidelines presented in section 1.7.5.3 (IFC guidelines) will be applicable to the project.

1.7.7.5 Terrestrial and Aquatic Habitat Alteration and Biodiversity

Construction and operation of the terminal facilities, involves activities that may result in alteration of terrestrial, freshwater, brackish and marine habitats, with impacts to flora and fauna and related biodiversity. Assess the potential impacts to shoreline vegetation, wetlands, coral reefs, fisheries, bird life, and other sensitive aquatic and near-shore habitats during port construction and operation. Incorporate the scope of land reclamation activities, and the assessment and management of associated environmental impacts into the project design. Additional guidance on the avoidance or minimization of impacts to habitats during design and construction activities is presented in the General EHS Guidelines.

1.7.7.6 Occupational Health and Safety

The occupational health and safety issues that may occur during the construction and decommissioning of terminals are similar to those of most large infrastructure and industrial facilities. The most significant occupational health and safety hazards occur during the operational phase of the terminal. They primarily include – process safety, chemical hazards, confined spaces, exposure to organic and inorganic dust and exposure to noise. Their prevention and control are discussed in the general EHS Guidelines.

1.7.7.7 Community Health and Safety

The port operators have responsibility for the safe operation of ships. As such, operators should implement a Safety Management System (SMS) that is informed by initial risk and hazard assessments and should include consideration of alterations to coastal processes and seabed and coastal geomorphology that may impact navigational and vessel berthing activities. Port operators should also have a clear understanding of their responsibilities, including international legal and technical obligations to provide security to passengers, crews, and personnel in port. Further, it is important to note that permanent and temporary installations and ships can make visual changes to the landscape. One of the most significant changes attributable to ports is nighttime illumination, depending on the proximity of the port and associated bulk storage facilities to sensitive land uses such as residential or tourist areas, Excessive illumination may also result in changes to invertebrate flight paths and settlement/breeding patterns. MM FZE should strive to minimize excessive background illumination during the port planning process or managed during operations through the installation of natural visual barriers such as vegetation or light shades, as applicable.

1.7.8 Project Specific EHS Policies and Standards

1.7.8.1 Indorama's Non-Discriminatory Policy, 2021

MM FZE is an equal opportunity employer and as per the Non-Discriminatory Policy does not and shall not discriminate against any employee or any applicant for employment on the basis of race, colour, religion (creed), gender expression, age, disability, military status, sexual orientation, and national origin in any of its activities or operations. These activities include but are not limited to employment – recruitment, selection, hiring, compensation, termination, upgrading, promotions, and other conditions of employment.

1.7.8.2 Indorama's Child Labour Prohibition Policy, 2021

MM FZE does not and shall not offer employment nor employ any person below the age of eighteen (18) years. The Company maintains zero tolerance towards the breach of this policy.

In line with the Policy, MM FZE shall maintain appropriate documents of all relevant details of employees including their age and these documents shall be open for verification by authorized personnel or the relevant statutory body. The Human Resources Department is responsible for the implementation of this Policy.

1.7.8.3 Indorama's Human Rights and Labour Policy, 2021

The MM FZE Human Rights Policy is guided by the International Human Rights Principles as enshrined in the Universal Declaration of Human Rights, the ILO Declaration on fundamental Principles of Rights at Work, and the African charter on Human Rights on the constitution of the Federal Republic of Nigeria 1999, as amended. Specifically, MM FZE employees shall have the following rights:

- Freedom of association
- Freedom of express
- Healthy work environment
- Safety at workplace
- Non-discrimination
- Freedom of worship
- Freedom from bullying, sexual harassment
- Right to fair hearing
- Any other such rights as necessary and recognized by the law of the Federal Republic of Nigeria.

1.7.8.4 Indorama's Independent Contractors' Policy, 2021

For the purpose of this Policy, independent contractors are workers working for MM FZE. MM FZE directs all independent contractors working with the Company to strictly comply with the guidelines on the following internal policies: Employee Hand Book, Grievance Handling and Management Policy, Anonymous Grievance Handling Mechanism, Child Labour Prohibition Policy, Human Rights Policy, Non-discriminatory Policy, Retrenchment Planning (Redundancy) as stipulated in the National Labour Law, Work Place Discipline Policy, Security and Safety Policy, Employee Compensation Policy and any other policy necessary for the wellbeing of the independent contractors and their employees.

1.7.8.5 Indorama's Gender Based Violence and Harassment Policy, 2021

Indorama is committed to promote gender diversity in the organization and recognizes the potential risk of Gender Based Violence and Harassment (GBVH). MM FZE has a zero tolerance for GBVH and on continual basis endeavours to identify the risk areas, upgrade preventive measures; create awareness amongst both internal & external stakeholders, enhance capability building and increase effectiveness of grievance management system. The objective this Policy is to define a policy framework and define strategies for addressing the issue of GBVH. This Document also aims to provide an integrated framework for stakeholder engagement and grievance management system with a focus on GBVH at all states of business cycle.

1.7.8.6 Indorama's Anti-Retaliatory Policy, 2021

Indorama is committed to providing access to effective grievance management systems for its employees, stakeholders, and local business partners. Further, MM FZE also expects from its local business partners working with the company to provide access to effective grievance management systems for its employees and stakeholders for freedom of expression and grievance redressal without any fear of Retaliation or victimisation. The objective of this Policy is to provide a framework, establish organisational commitment, assess risk, build organisation capabilities for preventative and mitigation measures, as well as proffer an effective grievance management system for safeguarding the human rights values.

1.7.8.7 Indorama's Community and Stakeholder Policy, 2021

MM FZE is committed to respecting the rights, cultures, customs, and values of employees and communities affected by its activities and will manage its businesses in a fair and equitable manner to meet its social responsibilities. The objective of the Policy is to ensure proactive engagement with key stakeholders on sustainable development challenges and opportunities in an open and transparent manner and to ensure effective grievance mechanisms are in place.

1.7.8.8 Indorama's Environmental & Climate Change Policy, 2022

MM FZE is committed to effective environmental management. The aim of this Policy is to minimise impacts on the environment and reduce impacts on climate change throughout its operations. The objective of the Policy is to ensure the development and implementation of Environmental Management Systems that are compliant with applicable national, regional, and local environmental regulations, and good international practice.

1.7.8.9 Indorama's Occupational Health, Safety & Wellbeing Policy, 2022

The Policy aims to promote the health and safety of employees, service providers, and any other person who is impacted by MM FZE operations. The goal of the Policy is zero harm as well as safe and healthy workplaces.

1.7.8.10 Indorama's Product Stewardship Policy, 2022

MM FZE is committed to the highest standards of product safety, quality, and business integrity to meet customer expectations and achieve customer delight. The Policy goal is to minimise the health, safety, environmental, and social impacts of their products.

1.7.8.11 Indorama's Responsible Business Policy, 2021

The Responsible Business Policy objective is to make positive contributions to the economic, environmental, and social progress at the locations where MM FZE operates. MM FZE is committed to promoting business practices that provide benefits to society, transparently and ethically, and address potential negative impacts associated with its operations.

1.7.8.12 *Indorama's Social Media Policy, 2021*

The Indorama Social Media Policy provides a framework for use of social media for corporate or personal accounts to protect against damage to the organization. The policy objective is to provide practical ways to avoid issues that may arise from the improper use of social media.

1.7.8.13 *Indorama's Confidential Reporting Policy, 2021*

MM FZE is committed to high ethical standards and encourages reporting of any acts listed below by any employee irrespective of their position. The Policy prohibits anyone from retaliating against any person who in good faith raises or helps to resolve any of the acts below or any other ethical concern. Confidential reporting applies to:

- Any violation of Indorama's Code of Conduct.
- Any act that adversely affects the business interest of MM FZE.
- Any act that is illegal under local or international law.
- Any abuse of authority.

1.8 Report Structure

In line with the FMEnv Procedural Guidelines, this ESIA study has been organised into nine main chapters:

- **Chapter One**: Introduction containing an overview of the proposed project, the objectives and scope of the ESIA study and applicable legal and institutional framework.
- **Chapter Two**: Project Justification containing a rationale for the proposed Project, as well as the analysis of Project alternatives.
- **Chapter Three**: Project Description containing the technical elements of the Project.
- **Chapter Four:** Description of existing environmental and socio-economic conditions of the Project Area of Influence (AoI). This chapter details the baseline data relevant to decisions about the Project location, development, and operation.
- **Chapter Five**: Discussion of all relevant environmental and socio-economic risks and impacts of the Project, including associated and cumulative impacts.
- **Chapter Six**: Mitigation measures for the identified environmental and socio-economic impacts and a discussion of residual impacts.
- **Chapter Seven**: Environmental and Social Management Plan for the Project. This chapter summarizes the key measures and actions and the timeframe including responsibility for the implementation of the recommended measures. This chapter will refer to a standalone ESMMP that will be included as an attachment / appendix to the ESIA.
- **Chapter Eight**: Decommissioning and remediation plan for the proposed Project at the end of its operating life.
- **Chapter Nine**: Conclusion and Recommendations.

This ESIA study will also contain a table of contents, acknowledgement, an executive summary, and list of references. The ESIA report is supported by the following Annexures and Appendices:

- Annexure 1.1: FMEnv Letter _ Project Categorization
- Annexure 1.2: FMEnv Approved TOR & Scoping report
- Annexure 4.1 Meteorological data
- Annexure 4.2: Air Quality Results
- Annexure 4.3: Noise Results
- Annexure 4.4: Soil Quality Results
- Annexure 4.5: Sediment Quality Results
- Annexure 4.6: Geology/Hydrogeology Data
- Annexure 4.7 Plant Species List
- Annexure 4.8 SIA/HIA Questionnaire
- Annexure 4.9 Indorama Port CSR Project for Onne and Ogu
- Annexure 4.10: Details Cultural Heritage Resources & Map
- Annexure 4.11: Traffic Survey Data
- Annexure 4.12: Comprehensive Stakeholders Engagement Report
- Appendix A: Environment and Social Management and Monitoring Plan (ESMMP)
- Appendix B: Stakeholder Engagement Plan

1.9 Declaration

MM FZE has proposed to embark on a Port Terminal project within existing Onne Port Complex. In the planning, construction, operational and decommissioning stages of this project MM FZE shall:

- Comply with environmental regulations, laws, statues, and edicts.
- Adopt appropriate measures to mitigate, identified and predicted adverse environmental impacts arising from or associated with the project and enhance positive impacts.

CHAPTER – TWO

PROJECT JUSTIFICATION

2.1 Introduction

This *Chapter* provides the rationale for developing the Project. Further, the *Chapter* highlights the Project alternatives considered in the ESIA study in terms of technology, siting, and other Project development options (i.e., no Project Option, Delayed Project Option and Project Option).

2.2 Need for the Project

Investment in infrastructure across Africa is essential, in that it is the catalyst to facilitating domestic and international trade and enhancing countries like Nigeria integration into the global economy. MM FZE seeks to overcome such infrastructure constraints in Port Harcourt by establishing a port terminal to facilitate export of fertilizer products.

At present, Indorama has two operating lines (Train 1 and Train 2), which both independently produce 2,300 Metric Tons Per Day (MTPD) of ammonia and 4,000 MTPD of urea fertilizers. The total production capacity is 2.8 million tonnes of urea per year, out of which approximately one million tons of Urea fertilizer is sold locally, while the remaining volume is exported to Latin America (mainly Brazil), West African countries, the USA and India through the operational Oil and Industries Services (OIS) Indorama Port Limited (OIPL). Indorama is setting up Train 3 expansion to produce additional 2,300 MTPD of ammonia and 4,000 NTPD of urea. All three Trains will generate 375 MTPD of ammonia over and above the requirement of urea plants. It is on this backdrop that MM FZE seeks to establish the new Port Terminal to export the surplus ammonia and 1.4 million tons of urea. The target countries of export include Latin America, Europe, USA, and West Africa. Currently, the train 3 fertilizer plant construction is ongoing, levelling and pilling have started, and the plant is expected to be commissioned in second quarter of 2026. Upon Train 3 completion about 420MT/day (150KTA) excess ammonia more than the requirement of the urea plant will be produced from all three Trains. This excess ammonia will be exported using the proposed MM FZE Port Terminal to Latin America (mainly Brazil), West African countries, the USA and India.

At a global scale, the demand for urea has been growing at a compound annual growth rate (CAGR) of 1.9% and is estimated to reach USD 62180 million by the end of 2027[1]. With the continued increase in land area under crop production in South America & Asia, urea demand is likely to outstrip supply on longer term.

[1] https://www.digitaljournal.com/pr/urea-fertilizers-market-global-analysis-2022-2027-expected-to-reach-usd-62180-million-and-exhibit-a-cagr-of-1-9-price-forecast-key-players-strategy-rising-demand-revenue-and-growth-rate-throu

On a regional scale, the consumption of fertilizer in Africa is still low at about 3% of world consumption (AfDB, 2019)[2]. The forecasted annual growth rate by the Food and Agricultural Organisation (FAO) is 3.86%, indicating a need for increased supply availability in the region. Similarly, the International Fertilizer Association estimated a growth of 37% between the year 2016 and 2021 out of which Nigeria was anticipated to contribute 28% of the regional demand growth. Sub-Saharan Africa has an average fertilizer application rate of 22 kilograms per hectare (kg/ha), compared to a world average of 146 kg/ha[3]. There is thus need for continued investment in the fertilizer supply chain in the region to increase fertilizer production and supply to meet the targeted fertilizer consumption of 50kg/ha in sub-Saharan Africa.

2.3 Project Benefits

The Project is anticipated to come along with a range of benefits that include (but not limited to):

- Opportunity to supply an ever-increasing global demand for fertilizer.
- The world population has more than doubled in the last 50 years from 3.77 billion in 1971 to 7.89 billion in 2021[4]. As of 2023, the world population growth rate stands at approximately 0.88%[5] per year and fertilizer demand is proportionate to population growth. The population growth in Africa is higher than world growth and hence access to fertilizer would have significant positive impacts to food security of the world and Africa at large.
- Increased access to fertilizer to Nigeria and other West African countries, especially given the drive to increase Nigeria's fertilizer consumption from the current 20 kg/ha to 50 kg/ha.
- Creation of employment for approximately 705 personnel (32 expert staff and 673 national staff) during the construction and pre-commissioning phase and approximately 220 personnel (10 experts' staff and 210 national staff) during the operational phase.
- The export of fertilizer is anticipated to generate revenue to the country and transform Nigeria to a net exporter of Urea fertilizer in the region.

2.4 Value of the Project

The investment is aimed at: enhancement of supply/distribution networks and the provision of new employment opportunities for the growing demand from the young Nigerian population. The Project will be able to derive valuable foreign exchange from the Urea and Ammonia that will be exported, as well as improve the local economy in the immediate Project area.

The envisaged capital cost of the MM Port Facility within the Onne is approximately USD 130 million. The MM Port terminal facility is expected to export 1.4MMT of Urea and 150KTA of ammonia annually, thus the actual and potential income will be dependent on the market rate. However, the return on investment is expected within 8-10 years of the facility operation. Moreso, other benefit that will accrue

[2] https://www.afdb.org/sites/default/files/2019/10/21/cross-border_study.pdf

[3] https://blogs.worldbank.org/voices/transformed-fertilizer-market-needed-response-food-crisis-africa#:~:text=Fertilizer%20exports%20from%20Belarus%20and,to%20protect%20their%20own%20farmers.

[4] Population, total - World | Data (worldbank.org)

[5] https://www.macrotrends.net/countries/WLD/world/population-growth-rate

to this investment will include job opportunities, new skill acquisition/transfer and revenue generation for the government. The current capital cost has factored in the market volatility in accordance with global pricing index, while funds will be made available by international financiers (IFC, World Bank, AfDB and EBRD). During the project implementation value chain for host communities will be in accordance with the Local Content Act.

2.5 Envisaged Sustainability

2.5.1 Technical Sustainability

The Project is anticipated to be technically sustainable due to the following:

- The Proponent will design, construct, and operate the Project in strict adherence to internationally accepted codes, standards and best practices for engineering design and construction such as (but not limited to):
    - American National Standards Institute (ANSI).
    - American Society of Mechanical Engineers (ASME).
    - National Association of Corrosion Engineers (NACE).
    - National Fire Protection Association (NFPA).
    - International Electrotechnical Commission (ICE).
    - Institute of Electrical and Electronics Engineers (IEEE).
    - Institute of Electrical and Electronics Engineers (ISA).
    - Network Information Service (NIS).
- The new port facility at Onne will be constructed by a qualified construction company or by the same contractor that implemented dredging, reclamation and construction works for the development of the OIS Indorama Port Limited (OIPL), Project in 2013 for IEFCL.
- The Project will employ the same design and technologies as used for the development for OIPL in Onne, Nigeria[6], which has demonstrated a high degree of operability and reliability.
- The Project has undertaken detailed studies to support the design of new port facility that include geotechnical investigations, dredging method statements and traffic studies.
- MM FZE has technically competent personnel required for effective operation of the Project.
- Currently, selection of construction contractor is under discussion and has not been finalised, however selection of construction contractor will be based on technical competence, experience and verifiable track record of similar projects executed somewhere.

2.5.2 Environmental Sustainability

Provided that all the E&S mitigation / management measures provided in this ESIA and associated ESMMP are implemented, and provided that the suggested ways forward are a condition of authorisation, it is the opinion of ERM that there are no E&S fatal flaws or red flags which inhibit

[6] Method Statement: No. MST_4883_01: The Dredging and reclamation works for the Development of the Onne Terminal Jetty Project at Onne, Nigeria for Indorama – Eleme Petrochemicals by Lubrik Engineering Services, 2013

authorisation of the Project. Moreover, the positive E&S benefits (refer to Section 2.3) of the Project also need to be considered in the authorisation decision.

The ESIA process does not stop with submission of the Project ESIA report to the FMEnv. Following submission of the ESIA, work will continue to address acknowledged information gaps and detailed design of the Project will progress. As additional data is gathered, a greater level of certainty regarding the impacts of the Project will emerge. Additional data and any further changes to Project scope should be re-evaluated in terms of their influence on impact significance, and if necessary, mitigation / management measures included in the ESMMP should be amended to ensure negative impacts are mitigated and positive impacts enhanced.

2.5.3 Economic Sustainability

The strategy of the Federal Government is to develop and refurbish port infrastructure across Nigeria, as such infrastructure is the catalyst to facilitating domestic and international trade and enhancing countries like Nigeria integration into the global economy. As such, the Project compliments this strategy and in addition, has the potential to realise local, national, and international (both across Africa and abroad) benefits summarised in Section 2.3.

In particular, the Nigeria Ports Authority is prioritising port development in the south-south region (Onne and Rivers Ports), so that they can serve as competitive alternatives to the ports in Lagos[7].

In addition, the Project at Onne will help to correct the existing international market imbalance in terms of supply and demand of urea fertilizer. Presently the per capita consumption of fertilizer is very low in Africa.

The Project will therefore improve the following areas of the economy:

- The local economy and development of other downstream medium scale industries such as shipping.
- Valuable foreign exchange for exported ammonia and urea.
- Direct and indirect employment of the local population.
- Substantial indirect employment for plant construction, transportation, and support services.

2.5.4 Social Sustainability

MM FZE is committed to meet the ever-increasing regional and international level demand of fertilizer, which in turn is a key enabler to achieving food security in Africa and abroad. As mentioned previously, the Project will provide employment opportunities during all phases (construction and operations). A detailed stakeholder consultation process has been (and continues to be) implemented throughout the ESIA process to assist in ensuring that all relevant stakeholders have had the opportunity to provide input into the Project planning process. MM FZE will ensure that the stakeholder consultation process is sustained throughout the life of the Project as set out in the SEP. This robust and all-inclusive engagement has led to a positive relationship between the Proponent and host communities.

[7] https://nigerianports.gov.ng/2022/02/12/modernization-of-port-infrastructure-underpins-nigerias-economic-future-md-npa/

2.6 Project Alternatives

In accordance with the Nigeria EIA Act No 86 of 1992 (now codified as the EIA Act CAP E12 Law of the Federation of Nigeria, 2004), an ESIA study should consider technically and economically feasible alternatives for carrying out a project, including an assessment of the environmental effects of alternatives. Additionally, the Federal Republic of Nigeria through Official Gazette No. 105, Vol 108 published S.I No. 109, Environment Impact Assessment Procedures and Charges Regulations in September 2021. These Regulations require that the alternatives be considered based on technology, site, energy, or water requirements. The Project has therefore considered the following alternatives:

2.6.1 Technology Alternatives

As mentioned in *Section 2.5.1*, the Project will use the same technology employed for the development of OIPL in Onne, Nigeria which has demonstrated a high degree of operability and reliability.

- The Project employs a traveling ship-loader mounted on rails. Travelling loader facilities are the more efficient compared to stationary bulk loader or a stationary crane and clamshell, rail boxcars, or trucks[8].
- The Project will include bulk storage and loading systems. The use of mechanical handling systems present minimal health and safety risks and minimal exposure of potential pollutants to the environment e.g., pumping of ammonia from storage tank to the ship and the use of rail mounted travelling ship loader for loading urea. The environmental monitoring data of the existing OIPL facility has demonstrated efficiency of this system (mechanical handling) which is the reason for adopting same system for the proposed MM Port Terminal.
- Dedusting units shall be installed at Truck Unloading Station and outtake conveying system to capture the urea dust generated during the handling. Dust suppression prevent the escape of fines and dust. Dust control is especially important at conveyor transfer points.

As such, although technology alternatives in terms of design and technology are reasonable, it is not financially or environmentally reasonable. As such, technology alternatives will not be considered any further in this ESIA.

2.6.2 Site Alternatives

This new terminal will be approximately 20 km away from the manufacturing site. A transport route has been identified from the manufacturing site to the new terminal to ensure efficient transport of urea and ammonia by means of covered tipper trucks. Indorama has a similar infrastructure port terminal at Onne and therefore has experience in port operations in the Project area. In addition, the Project is located within already developed Onne Port Complex on reclaimed land.

Other major advantages to locating the Project adjacent to the existing complex includes:

- E&S impacts can be adequately managed / controlled (i.e., no fatal flaws or red flags have been identified).

[8] https://pdf.usaid.gov/pdf_docs/PNRAA163.pdf

- The relationship between the host and neighbouring communities is positive.
- No physical or economic resettlement is anticipated from the Project.

While alternative location alternatives are reasonable, it is not financially feasible (or reasonable) to identify other sites at this stage, as there are no E&S fatal flaws or red flags associated with the proposed location of the Project. As such, location alternatives will not be considered any further in this ESIA.

2.7 Project Development Options

2.7.1 No Project Option

The key potential disadvantages associated with the No Project Option include:

- Lost opportunity to supply an ever-increasing global demand for fertilizer.
- The world population has more than doubled in the last 50 years (refer to Section 2.3) and fertilizer demand is proportionate to population growth. The population growth in Africa is higher than world growth and hence no project option would put significant impact on the food security of the world and Africa at large.
- Lost contribution to the provision of fertilizer to other West African countries.
- Loss of opportunity of additional employment and development in the local area.
- Loss of additional revenue stream in Nigeria, which in turn will affect local, regional, and national government revenues.
- Cumulative loss in fertilizer supply could potentially increase fertilizer prices regionally (i.e., West Africa), therefore affecting future price stability for fertilizer and potentially agriculture food products[9].

Based on the above listed disadvantages associated with the no project option, this option was rejected as it will deprive the people the benefits that will come with project if embarked upon.

2.7.2 Delayed Option

The delayed alternative would result in the Project being installed at a later date. Reasons for pursuing a delayed alternative can vary, but this approach is typically taken when economic or political conditions are unfavourable for implementing the Project such as decrease in demand, political situations or where there is significant opposition from stakeholder and host communities. None of these conditions are applicable to this Project and its anticipated timeline.

If the Project were to be delayed, most preliminary work and associated efforts may need to be repeated or changed. A Project delay may also result in higher project costs due to inflation, which could affect the Projects overall profitability or viability, as well as a delay in realising the benefits highlighted in Section 2.3. For these reasons, the Delayed Option will not be considered any further in this ESIA.

[9] Mainstream demand for fertilizer is directly coupled with the demand for agricultural crops.

2.7.3 Go-ahead Option

The “Go-Ahead” option, or pursuing the Project outlined in this ESIA Report, will have numerous benefits for both MM FZE and the people of Nigeria. Given the Project benefits highlighted in Section 2.3, the ‘Go-Ahead’ alternative, or establishment of the Project, is preferred.

CHAPTER – THREE

PROJECT DESCRIPTION

3.1 Introduction

This chapter provides a description of the new port terminal including the associated infrastructure proposed to be developed at the Onne Port Complex in Port Harcourt, Nigeria. This Project description formed the Terms of Reference for specialist studies associated with the ESIA Report.

Indorama Corporation (Indorama) operates a Petrochemical and Fertilizer complex in Eleme, Port Harcourt, Rivers State, Nigeria having manufacturing capacity of 2.8 million Metric Tons per Annum (MMTA) of Urea and 440 Kilo Tons per Annum (KTA) of Polymers (Polyethylene and Polypropylene) utilizing Natural Gas and Natural Gas Liquids as feedstock.

The Petrochemical Complex comprising of Cracker, Polyethylene and Polypropylene plants have been in operation since 2006. The Fertilizer Complex consists of two trains of 2,300 metric tons per day (MTPD) of Ammonia and 4,000 MTPD of Urea. While the first train of Fertilizer was commissioned in 2016, the second train was commissioned in April 2021.

The manufacturing site has two gas processing facilities, captive power plants, as well as utilities and storage facilities. About 20 kilometres (km) from the manufacturing site, Indorama currently operates a port terminal primarily for the export of urea. The port having 300 meters (m) of quay, can handle vessels up to 65,000 Deadweight tonnage (DWT).

Meliora Methanol Free Zone Enterprise (MM FZE), a subsidiary of Indorama Group proposed the construction and operation of the Port Facility to export Urea and Ammonia, at the Federal Ocean Terminal, Onne Port Complex, Onne, Eleme Local Government Area, Rivers State, Nigeria. The Urea and Ammonia to be exported from this proposed Port Terminal will be manufactured by IEFCL at Indorama Complex, Eleme, Rivers State.

Indorama intends to construct a third train of fertilizer plants (Train-3 Project) to produce 2,300 TPD of Ammonia and 4,000 TPD of and Urea. Along with the manufacturing facilities for the manufacture of fertilizers, Indorama intends to set-up a new port terminal situated at the existing Onne Port Complex on a plot having waterfront of about 350 m with all associated utilities to export Urea and Ammonia. (Figure 3-1).

The proposed project site is reclaimed sand filled site and does not have any structure. The Project area borders the undeveloped land to the north, and east, Operational Onne Multipurpose Terminal (OMT) on west and have waterfront at south. The total footprint of the Project is 20 hectares (ha) and there is no ecological sensitive area with the influence zone of the project.

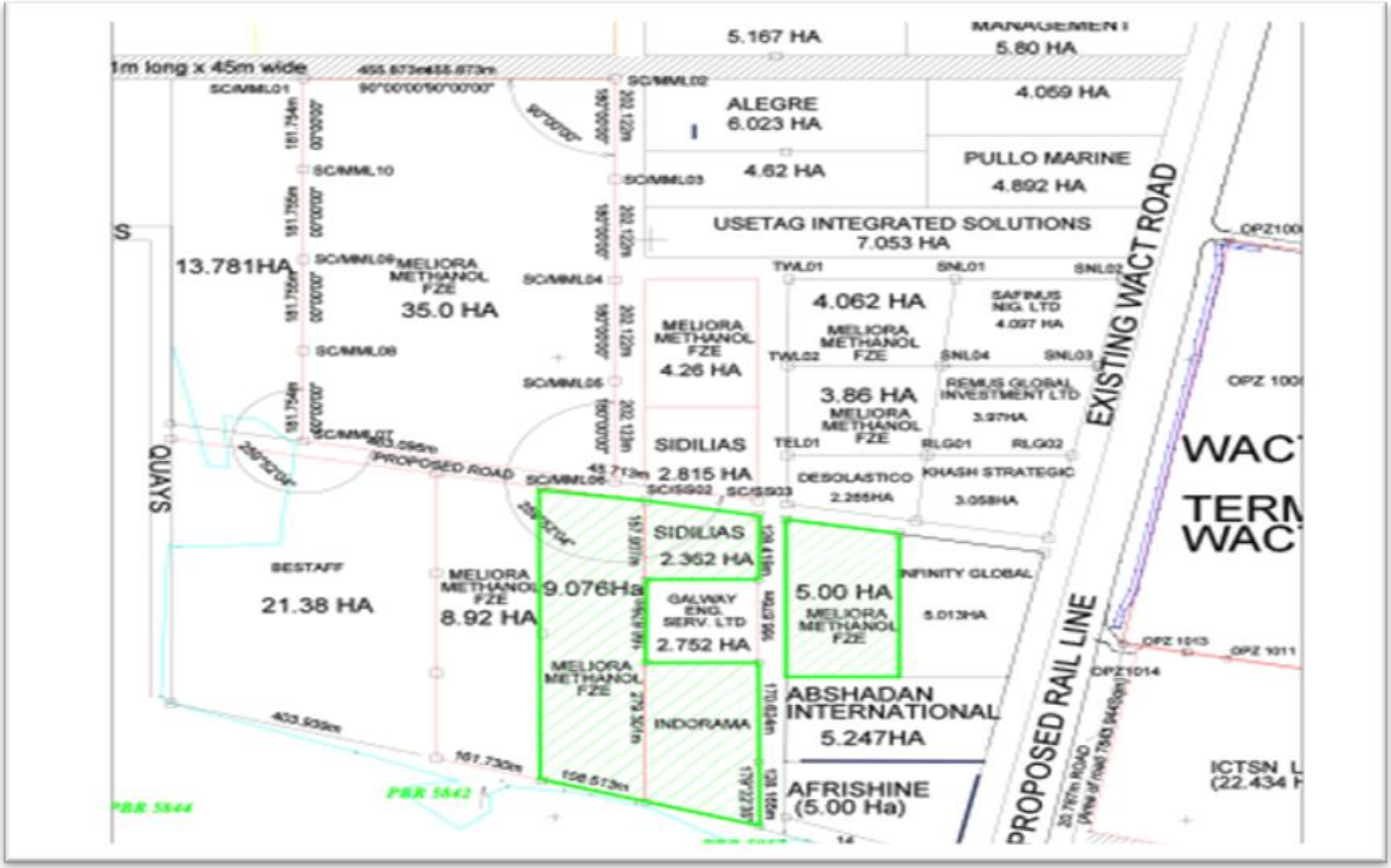


Figure 3-1: General Plan View

3.2 Project Location

This new port terminal will be within Onne Port Complex at Onne, Nigeria about 20 km away from the manufacturing site Figure 3-4. The location of Eleme within Rivers State in Figure 3-2 and the location of Rivers State in Nigeria is shown in Figure 3-2. The Project area borders the undeveloped land to the north, and east, Operational Onne Multipurpose Terminal (OMT) on west and have waterfront at south. The total footprint of the Project is 20 hectares (ha). The coordinates of the project site are Latitude $4^{0}50'3''$ to $4^{0}50'52''$ N and Longitude $7^{0}6'29''$ to $7^{0}6'55''$ E.

The new port terminal will have one berth with the capacity to handle and export 1.4 million Metric Tons per Annum (MMTPA) of granulated Urea and about 150 Kilo Tons per Annum (KTA) (approximately 420 MTPD) of Ammonia. Besides the quay, the new port terminal shall consist of Urea storage and handling system, The proposed layout plan is shown in Figure 3-5. Ammonia storages and handling system and associated facilities outlined in the sections which follow.

Figure 3-2 – Administrative Map of Rivers State showing Eleme LGA

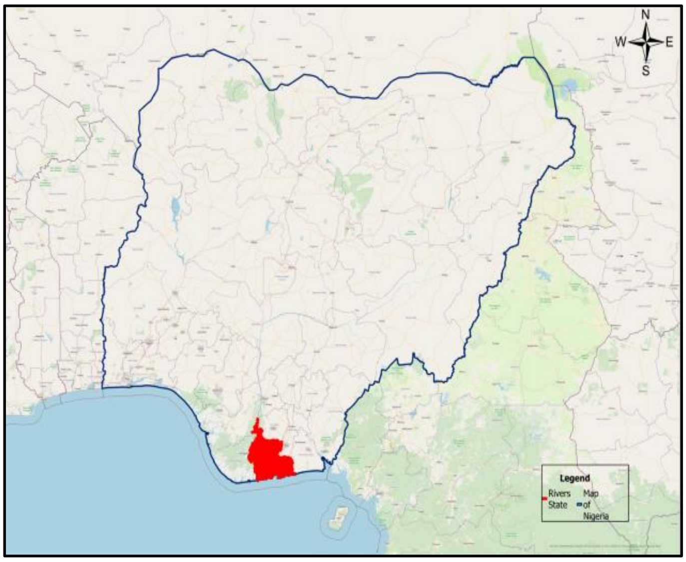


Figure 3-3 – Administrative Map of Nigeria showing Rivers State

Figure 3-4: Project Locality Map

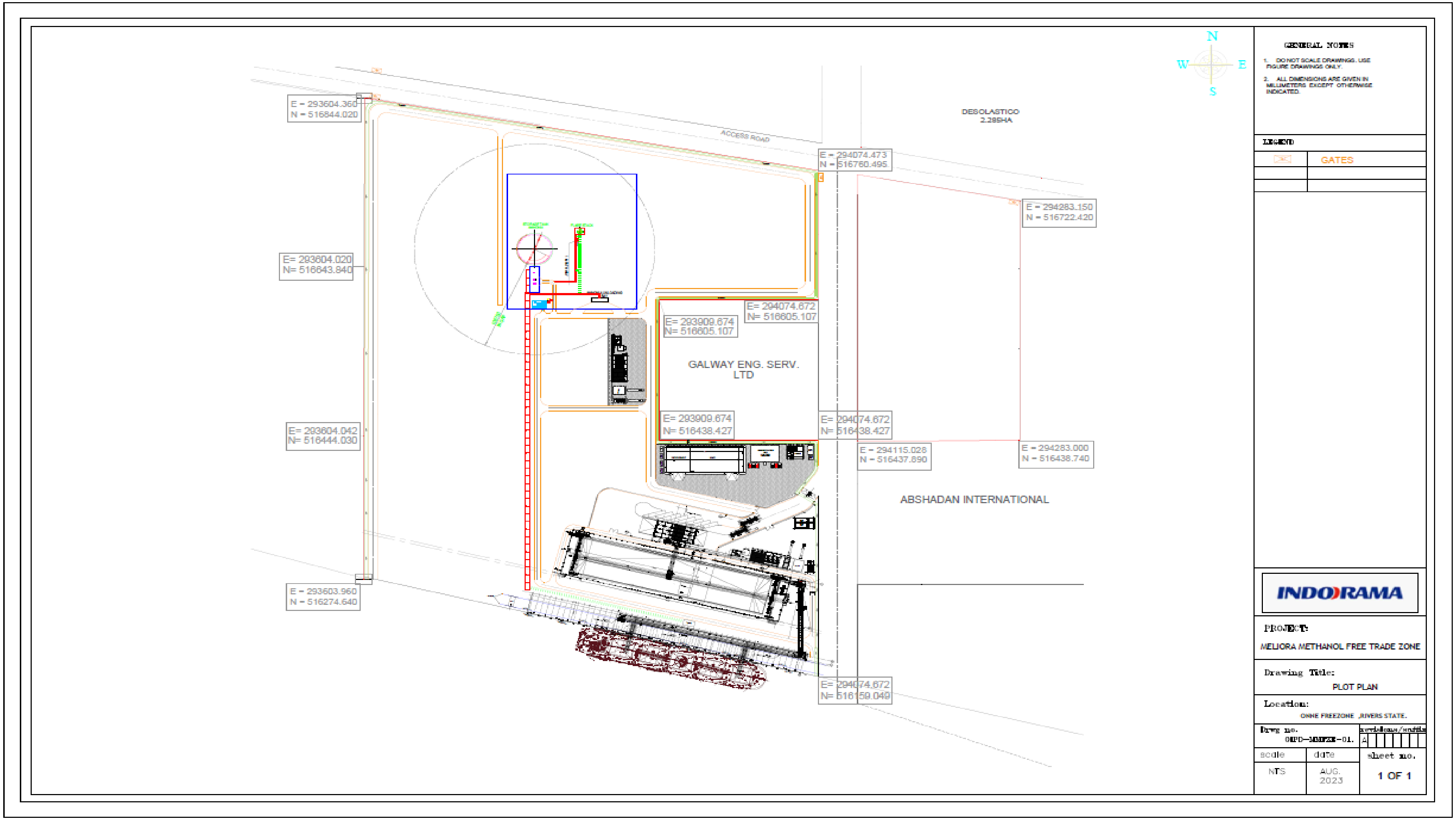


Figure 3-5: Port Terminal Layout Plan

3.3 Project Phases

The proposed Project will be developed in the following set phases:

- Design Phase
- Construction Phase;
- Operational Phase; and
- Decommissioning Phase.

Each of these four phases have a different combination of activities and the commencement of each phase is dependent on the outcome and success of its predecessor. It must be noted that the scope of the proposed Project, and the associated Project ESIA, relates to all four phases.

The Engineering contractor (contractor) will do basic engineering, detailed engineering, procurement assistance and co-ordination with package vendor for facilitating detailed engineering. The proponent will procure the equipment / packages based on the procurement documents prepared by the Contractor. Indorama will engage an experienced construction company for the construction activities. Construction and commissioning of the new port terminal will be done by proponent based on the relevant documents prepared by the contractor. The civil design and construction of loading platform, diaphragm wall along the shoreline, mooring / dolphin facility and other marine facilities will be done by the proponent. However, the contractor will provide the design inputs (layout, load, foundation details, etc.) of the facilities / equipment / racks / skids / piping, etc. to be installed on the jetty top side facilities. The above-mentioned Project phases are discussed in this Section.

3.3.1 Design Phase

At the end of the design phase, the proposed Project will be dimensionally correct, such that all the main components of the Project can be fully described. It is during this phase that the outcomes of the ESIA will influence how the proposed Project develops.

Project planning, decision-making and refinement of the Project will continue throughout the design phase, as a result of continued engineering studies, as well as per the findings of this ESIA and associated ESMMP.

3.3.1.1 Current Design

The Project design in terms of equipment design, layout, etc. is similar to the already operating Indorama's OIS Indorama Port Limited. MM FZE has already engaged an Engineering Contractor for the Project. For the purposes of this ESIA, the following regarding the Project is important to note:

- Project design is such that the Project will have an operational lifespan of 30 years.
- Design capacity is such that the Plant will operate 330 days/year.

The new port terminal will house the Urea storage and handling system, The Ammonia storage and handling system as well as the associated facilities are detailed in the Sections which follow. The new port terminal will have facilities as mentioned below:

Urea Storage and Handling

- Intake system
  - Truck weighbridges (incoming and outgoing)
  - Truck unloading station (TUS) simultaneously four trucks.
  - Conveying system from TUS to urea storage by means of belt conveyors, bucket elevator and reversible shuttle conveyor.
  - De-dusting system
- Storage
  - Warehouse having capacity 52000 MT.
  - Air handling unit
- Outtake system
  - Portal reclaimer
  - Belt conveyors.
  - Ship loader on jetty.
  - De-dusting systems
  - Belt weigher.

Ammonia Storage and Handling

- Ammonia Tanker Unloading System
- Ammonia Storage Tanks of 24,000 MT
- Flare stack for Ammonia Storage Tank
- BOG Reliquefication Unit
- Ammonia Ship Loading Pumps

Jetty top side facilities

- Ammonia Loading Arms
- Urea Loading System

Utilities and Other Facilities

- Cooling Water System for BOG Unit and air compressors
- Plant air, Instrument Air Unit, and nitrogen storage.
- Natural gas-powered generation unit inclusive of substation and distribution unit.
- Compressed Natural Gas (CNG) storage modules.
- Two borewells, each with a capacity of 20~25 cubic metres per hour (m^3/hr).
- Storage of groundwater from the two borewells, treatment, and distribution system.
- Sewage treatment plant of 20 KLD
- Two weighbridges of 100 Metric Tonnes (MT).
- Firefighting System Fire water pumps (sea water) and fire water network.
- Fire & Gas Detection and Protection System.

- Buildings: The new port terminal will also have below mentioned buildings,
  - Workshop / Maintenance area
  - Storage area for lubrication Oil and water treatment chemicals
  - Administration and Security Building

Moreover, architectural plans for the administrative building, Power generators & sub-station, Urea storage, transfer conveyors and ship loader are presented in Figure 3-6 to Figure 3-13.

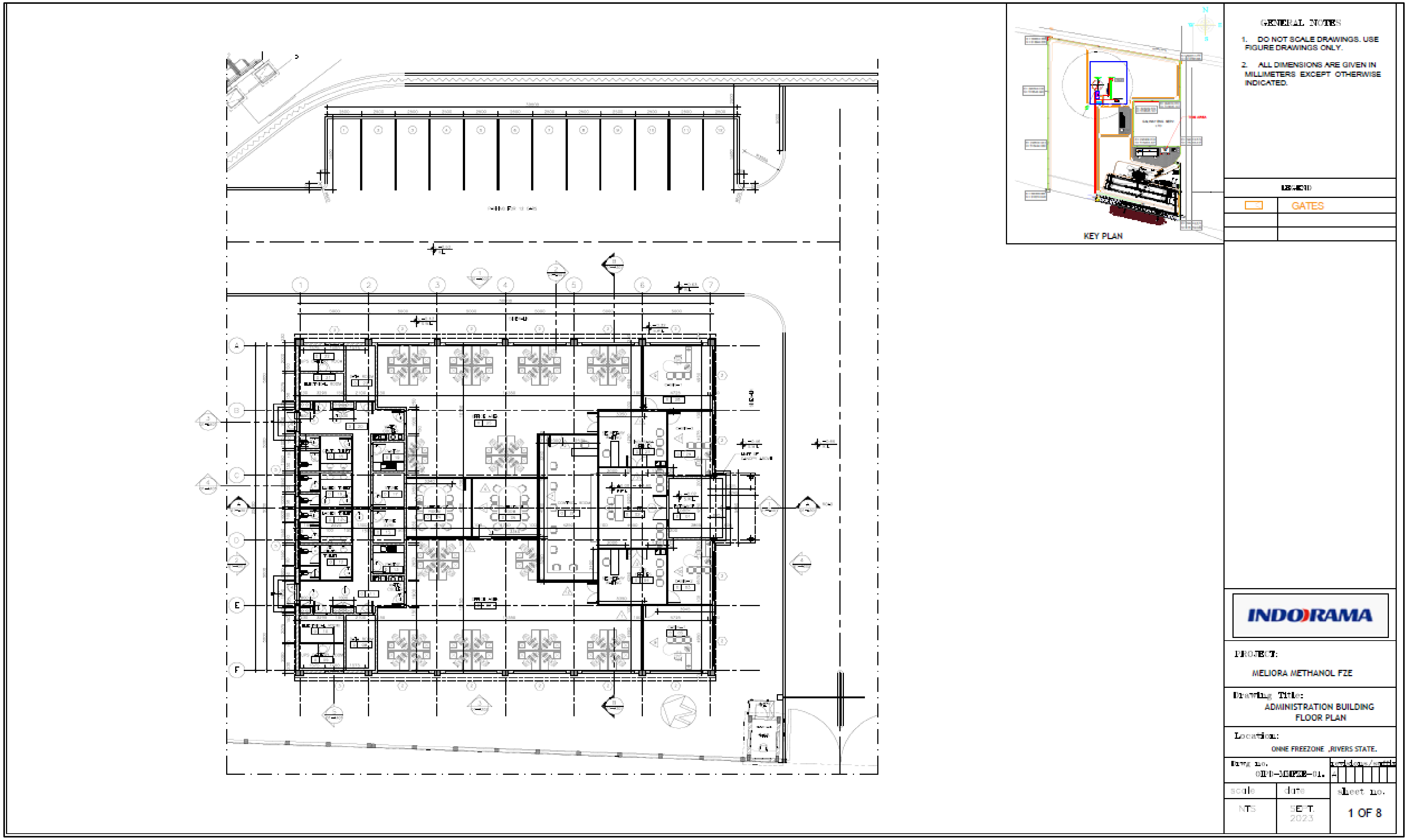


Figure 3-6: Administration Building Floor Plan

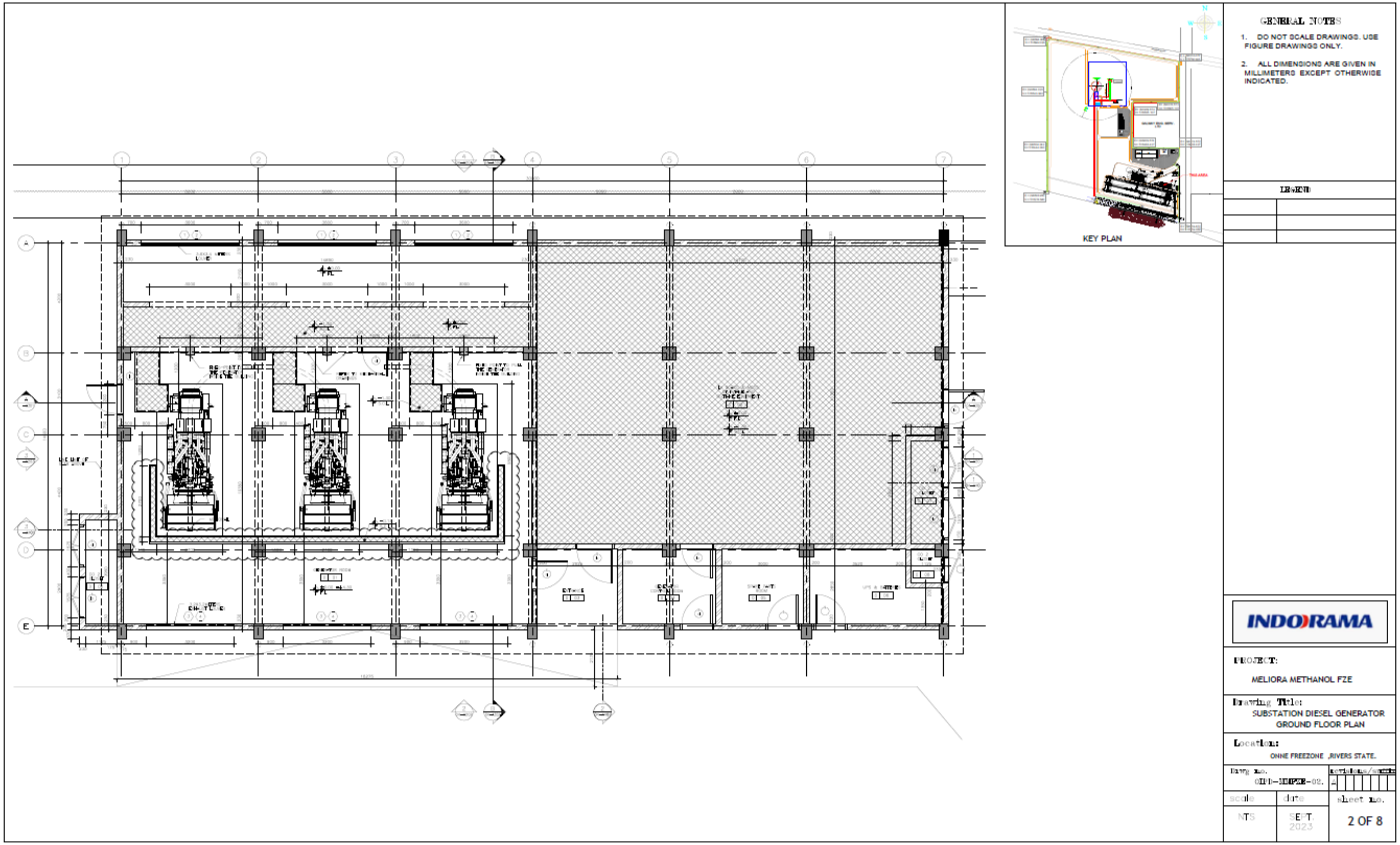


Figure 3-7: Sub-station and Generator Ground Floor Plan

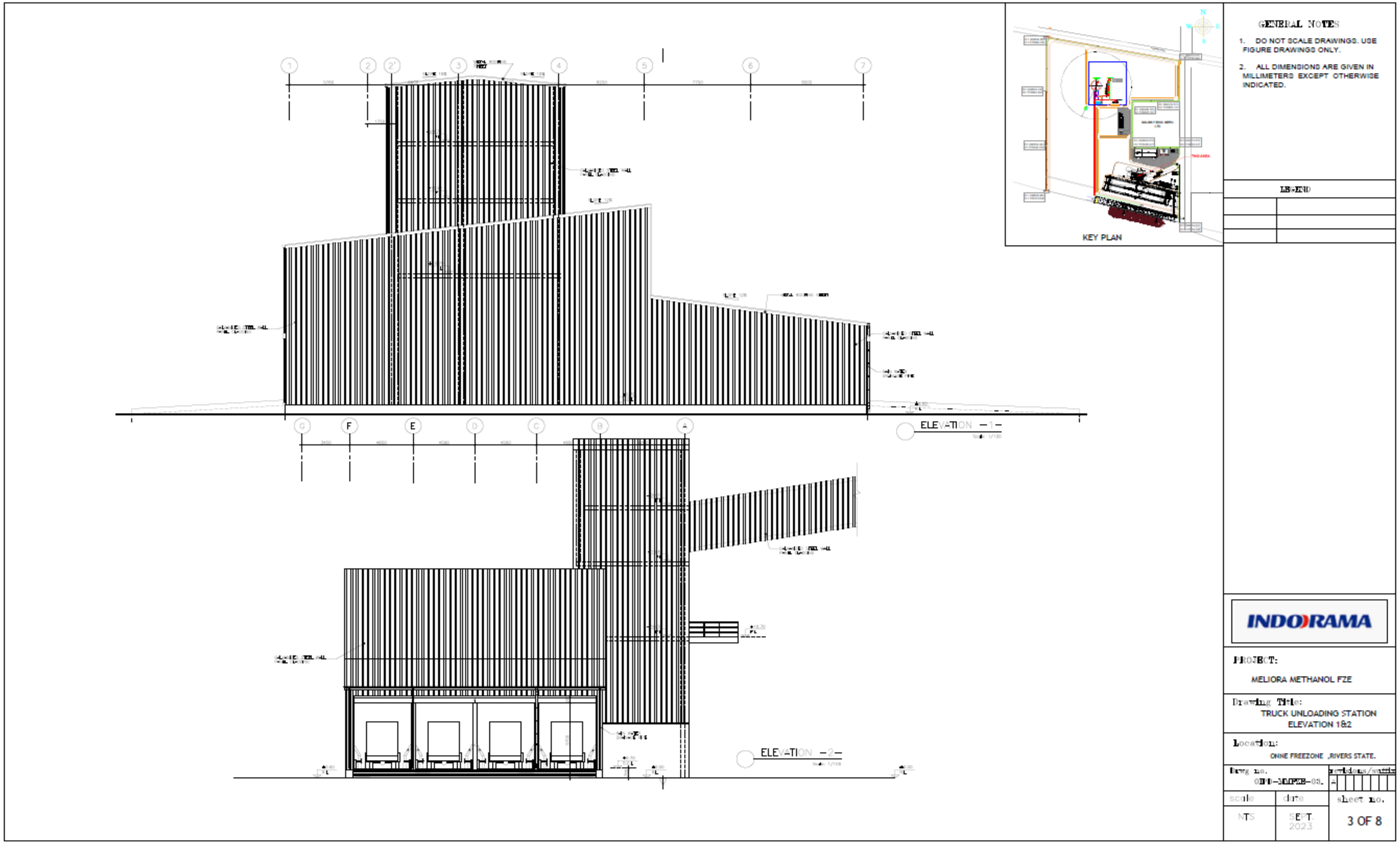


Figure 3-8: Truck Unloading Station Elevation 1 and 2

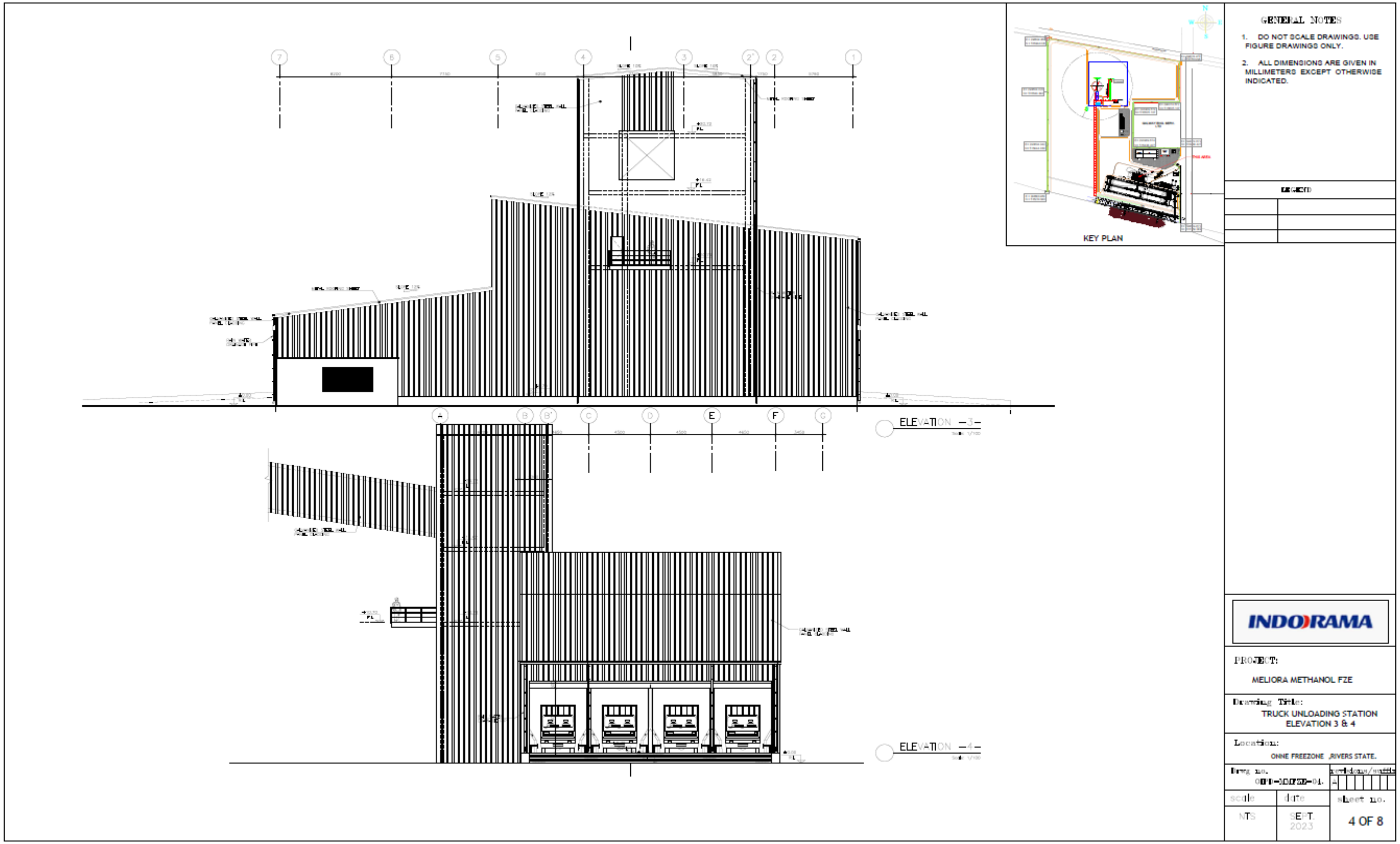


Figure 3-9: Truck Unloading Station Elevation 3 and 4

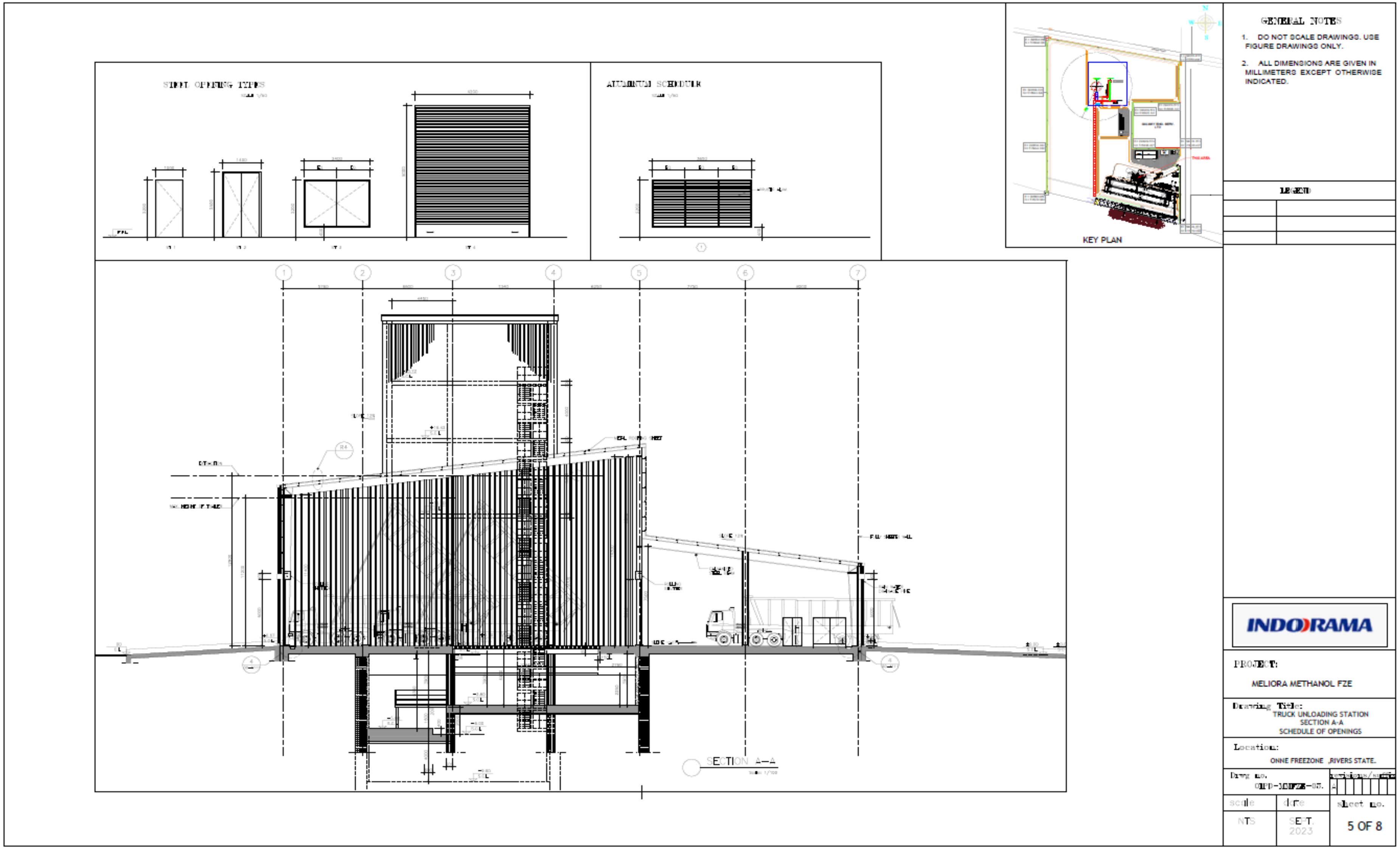


Figure 3-10: Truck Unloading Station – Section A-A

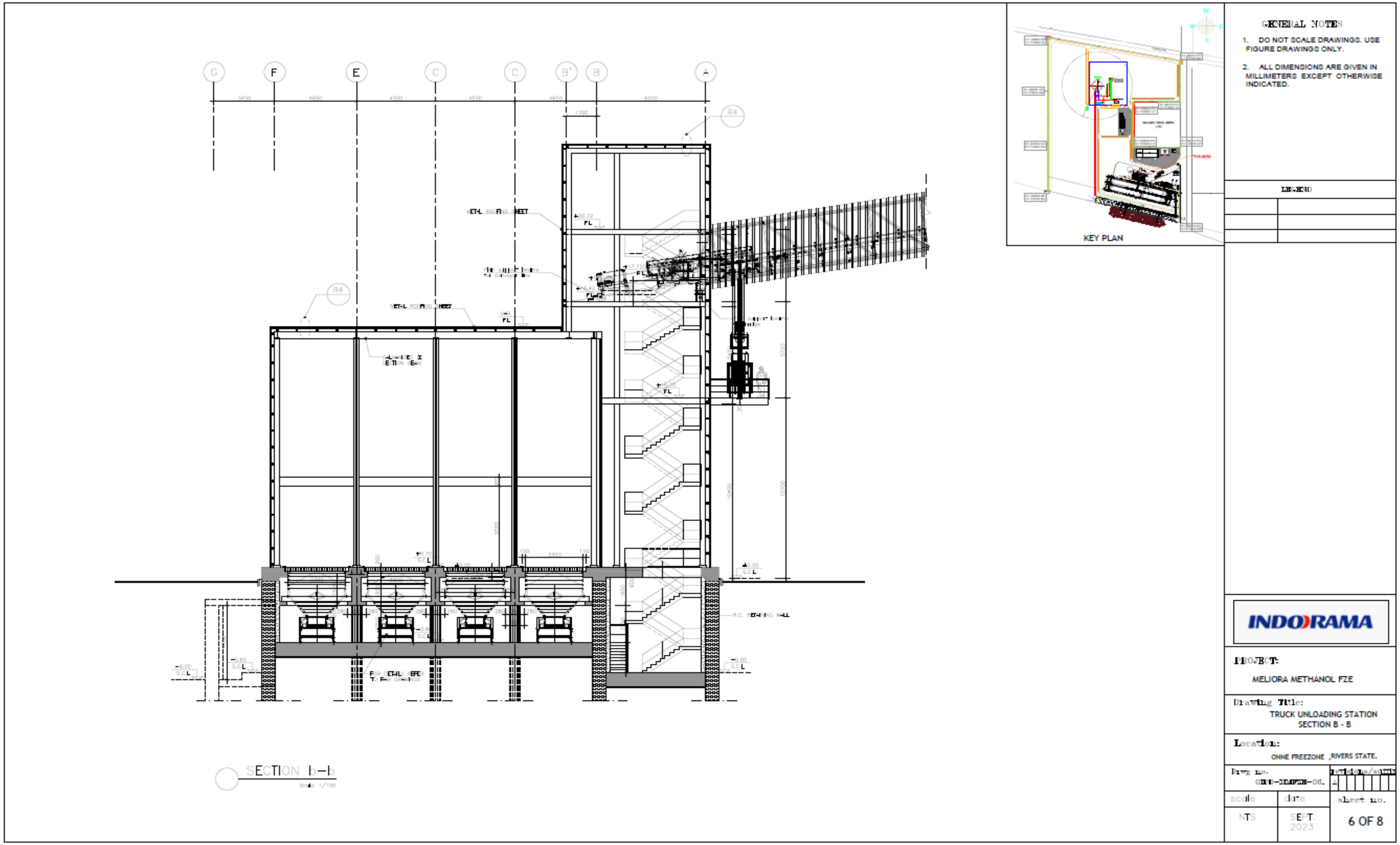


Figure 3-11: Truck Unloading Station - Section B-B

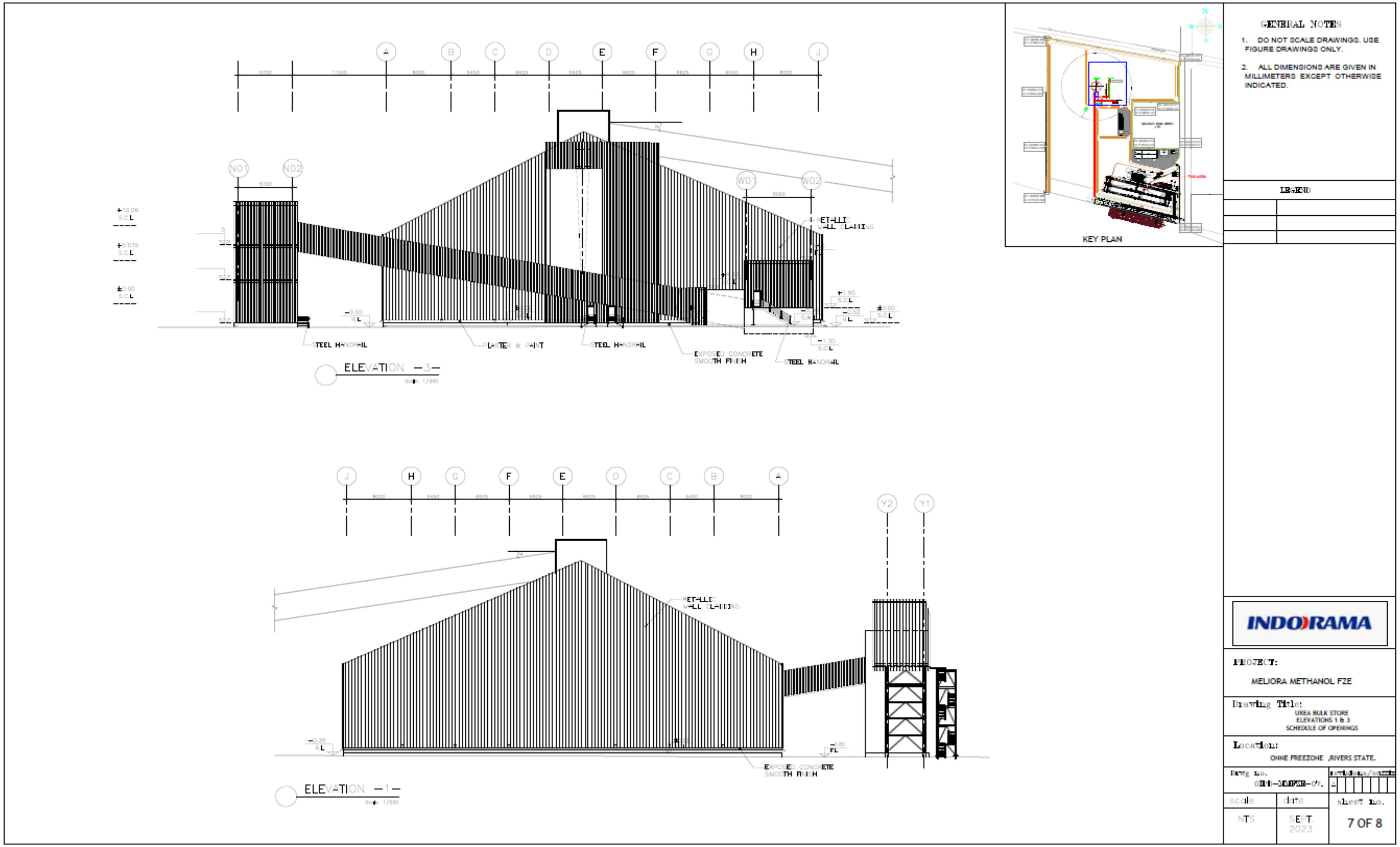


Figure 3-12: Urea Bulk Store Elevation 1 and 3

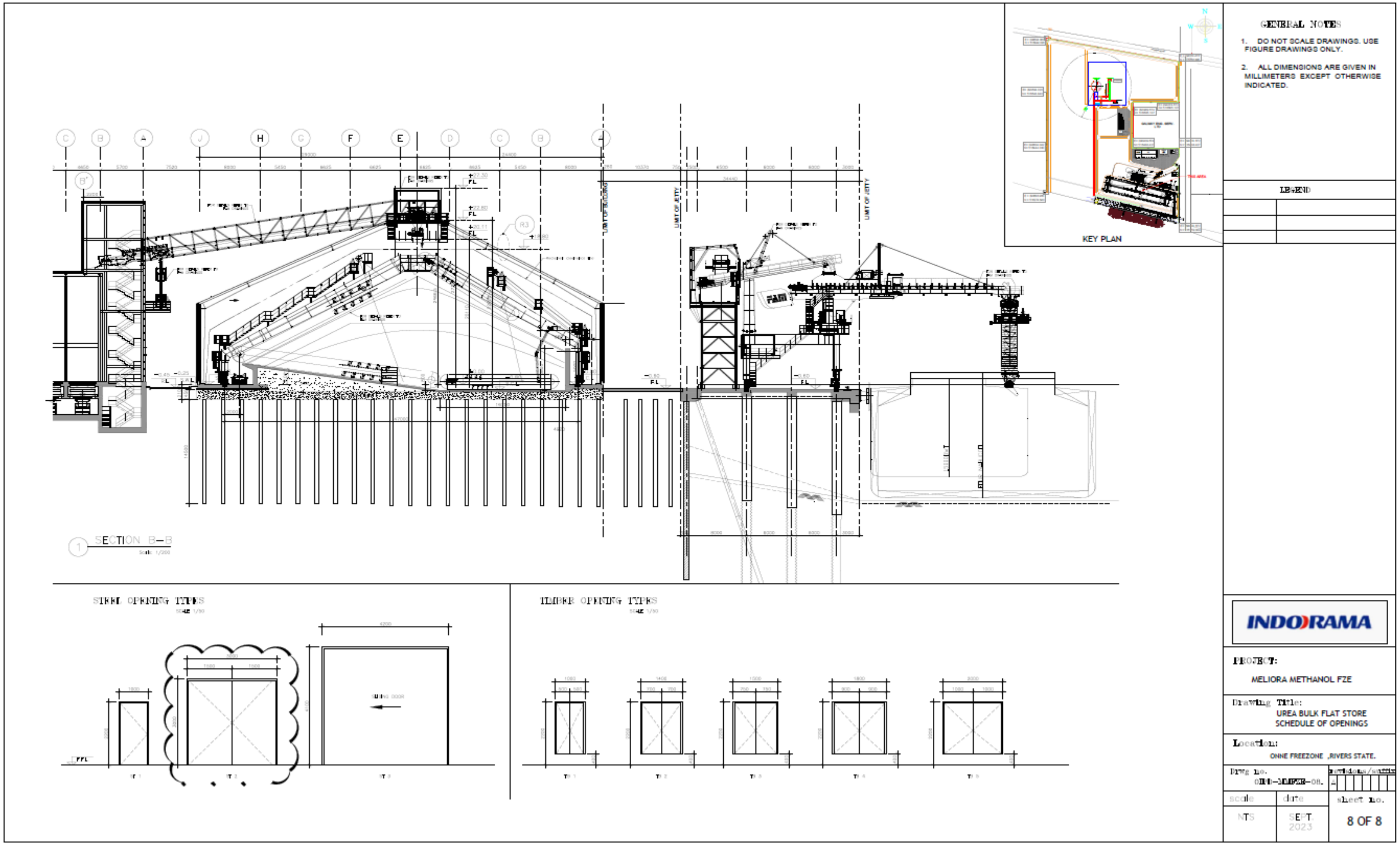


Figure 3-13: Urea Bulk Flat Store and Ship Loader

3.3.2 Construction Phase

The construction phase will not commence prior to the approval of the ESIA study. It is assumed that construction will continue for a duration of approximately 18 months. Activities during the construction phase will typically involve excavation works, concrete casting, civil works (specifically equipment foundations), installation of prefabricated structures & equipment, and establishment of the infrastructure. It should be noted that no construction activities will be undertaken during the night.

3.3.2.1 Construction Equipment

Construction activities will lead to increased traffic, due to the movement of employees and construction equipment/materials. Vehicular movement during this phase will include heavy-duty vehicles, trucks, buses, minibuses, and cars. It is proposed that the construction equipment such as the excavator, mixer truck, self-loader, water truck, poling crane, crawler crane, hydraulic crane, forklift, etc. will be used during the construction phase. It must be noted that the equipment, machinery, and vehicles will be used intermittently during the day, i.e., all equipment, machinery and vehicles will not be used simultaneously.

These activities are likely to result in an increase in environmental impacts over a limited period of time (duration of construction).

3.3.2.2 Labour Requirements during Construction

The construction workforce will peak at 673 national staff and 32 expatriate staff. The 673 national staff will consist of skilled, semi-skilled and unskilled personnel. Employment of Nigerians will be prioritised, with the seeking of local qualified and skilled Nigerian as a priority, The Project ambitions for recruitment of national staff during the construction and operation phase is provided in *Table 3-1.* This construction manpower ambitions are based on the experience gained during OIS Indorama Port Limited (OIPL) construction. The engagement of construction workers follows the existing set protocols that provide priority to the available workforce in Eleme and Ogu-Bolo LGAs and particular preference to the host communities. Unavailable skilled workforce in the catchment area will be extended to the Rivers State, other states of Niger Delta and other parts of the country. The workforce data presented in Table 3-1 shows the engagement pattern demonstrating that priorities have been provided to available workforce within the catchment area therefore reducing the influx aspect of the Project.

Table 3-1: Recruitment Ambitions during the Construction and Operation Phase

S No	Manpower Category	During Construction & Pre-Commissioning		Post Commissioning	
		Expat Staff	National Staff	Expat Staff	National Staff
1	Regular	7	30	10	210
2	Construction Peak	25	643		
	Sub Total	**32**	**673**	**10**	**210**

Construction manpower

Projected Total	Indigene Manpower	Non-Indigene (Nigerian)	Expatriates
643	257	354	32
%	40%	55%	5%

3.3.2.3 Construction Activities

The construction activities are as below:

- Fencing of the Project site
- Construction of internal roads
- Construction of storm water drains
- Piling for quay
- Diaphragm wall for quay and truck unloading station.
- Excavation and back fill
- Concrete works
- Erection of structural steel
- Erection of material handling system
- Electrical and instrumentation works.
- Installation of firefighting equipment
- Installation of Fire & Gas detection system
- Installation of Sewage Treatment Plant
- Construction of Ammonia Storage tank with other facilities
- Construction of buildings
- Installation of fenders, bollards, and safety ladders at quay
- Dredging of berth pocket

3.3.2.4 Dredging and Excavation

The construction works will require the deepening of the berth pocket in front of the quay to a depth of approximately 13 m. Dredging will be two-fold: using a Cutter Suction Dredger (CSD) and again using a Trailing Suction Hopper Dredger (THSD):

- Dredging Works with CSD
  - Dredging shallow areas in font of berth.
  - Pumping dredged material with floating line to the NPA designated Area
- Dredging Works with THSD
  - Re-dredging the disposed material.
  - Dumping the dredged material in approved Nigeria Ports Authority (NPA) dump sites.

Dredging works often use the following auxiliary equipment:

- Multipurpose tug (Multicat).
- Floating pipelines as required.
- Marine based survey equipment.

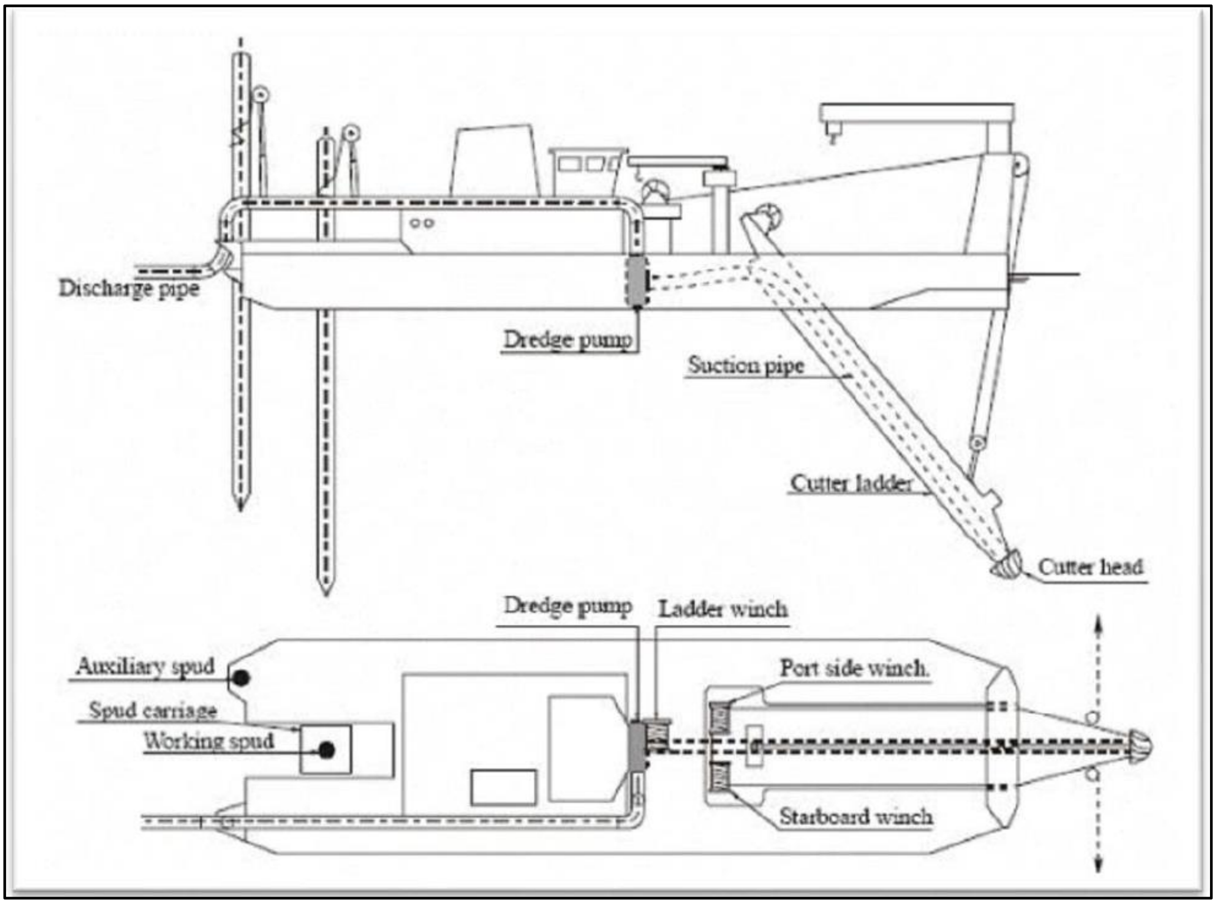
Cutter Suction Dredger

A cutter suction dredger is a stationary or self-propelled vessel that uses a rotating cutter head to loosen the material in the bed ('cutting'). There are two methods of discharging the dredged material:

- Direct pumping via a floating line (method adopted in this campaign); and
- Pumping into a barge via a special loading system.

Since in this campaign, no barge pumping is involved, this chapter describes the typical work cycle of a CSD based on the direct pumping method.

The important features of the CSD are shown in the figure below.



Source: Method Statement - Dredging of Indorama/OIPL Quay Wall in Onne (2015)

Figure 3-14: Main Features of a CSD

A typical CSD cycle for direct dumping consists of the following activities:

- Swinging movement.
- Stepping; and
- Movement of the anchors.

When the dredger is in place, the work spud sits in the sediment with the vessel positioned on the axis of the section to be dredged.

The spud carriage is drawn in, and the anchors are placed at a sufficient distance outside the cut. The ladder is then lowered, and the suction mouth submerged, before the pump is started. Water flow then begins, and the cutter starts to rotate. Finally, the ladder is lowered, and the sediment-water mixture can be sucked up. The various steps are explained in detail in the sections which follow.

Swinging

When the anchor wire is hauled in on one front side winch and paid out of the other, the front side of the cutter suction dredger moves sideways.

The cutter then swings in a circular path with the spud at the centre. The starboard winch and port winch alternately perform the tasks of hauling and paying out, meaning the cutter follows an arc from starboard to port side and back again.

The paying-out winch is usually used to exert braking force – when its braking torque is increased, the hauling winch has to use greater force in order to swing the dredger. This causes a tension in the anchor wires which creates a more rigid anchorage, resulting in better control over the sideward movement of the cutter. The conditions involved in the cutting process, in particular the sediment type and direction of hauling, have a significant impact on how much torque must be applied.

Stepping

At the end of a swinging cycle, when a cut has been dredged, the vessel must step and then swing again. This stepping is achieved by riding the spud carriage out over the desired step length.

The total distance which the spud carriage can travel is referred to as the stroke and is usually around 4 to 6 m long. When the spud carriage reaches the end of the stroke, the work spud must be repositioned in the centre line of the cut.

To do this, the side winches must be stopped, and the auxiliary spud lowered into the soil. This spud will then keep the suction dredger in position while the spuds are being moved. The next step is to hoist the work spud, before riding the spud carriage back into its initial position. The work spud is then returned to the soil, the auxiliary spud is hoisted and the side winches started, and the dredging process can re-start. This process is referred to as 'moving spuds'.

Moving the anchors

When a certain distance has been covered while in the same anchor position, the anchors must be shifted. If the dredger is at the end of the port side swing and the anchors are positioned too far backwards, the angle between the starboard hauling wire and the centre line of the vessel will be too small to exert an effective pulling force. It then becomes very difficult, or even impossible, to pull the vessel. For this reason, it is important to bring the anchors forward.

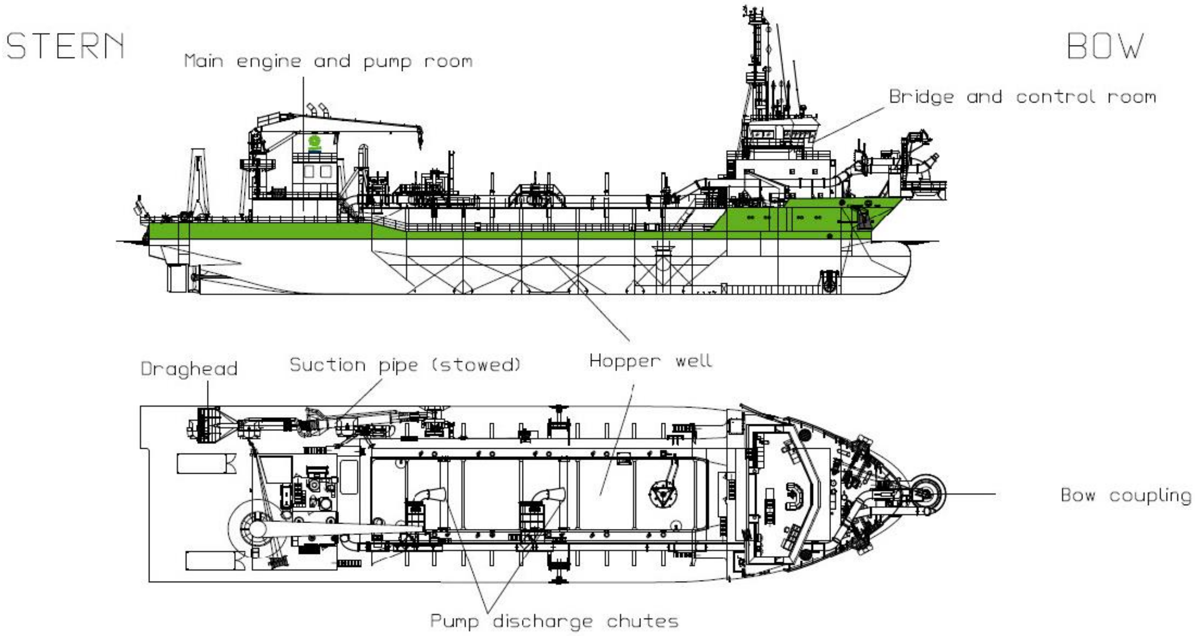
Trailer Suction Hopper Dredger

A Trailing Suction Hopper Dredger (TSHD) is a self-propelled vessel which can dredge while sailing, thus filling its hopper well, and which can transport the dredged material. There are three methods of discharging the dredged material:

- Direct pumping in a fill area via bow coupling;
- Rain bowing via bow nozzle; and
- Dumping in a discharge area – (method adopted in this campaign).

Since in this campaign, no direct pumping is involved, this chapter describes the typical work cycle of a TSHD based on the dumping method.

The important features of the TSHD are shown in the figure below.



Source: Method Statement - Dredging of Indorama/Oipl Quay Wall in Onne (2015)

Figure 3-15: Main Features of a TSHD

A typical TSHD cycle for direct dumping consists of the following activities:

- Sailing empty to borrow area;
- Dredging in borrow area;
- Sailing loaded to discharge area; and
- Emptying hopper well (discharging cargo by opening bottom valves).

Sailing empty to borrow area.

An optimum navigation route to the dredging area is selected based primarily on sailing distance and depth limitations. Safety, local regulations and local features are taken into account in the determination of the navigation route. This navigation route is plotted as a track in the electronic charts on board of the hoppers, allowing the hopper to closely follow this track.

Dredging in borrow area.

When arriving at the dredging area, the speed of the hopper is reduced and the draghead(s) are lowered to the sea bottom and the dredging can commence.

The dredger takes up a mixture of water and soil through the draghead(s) and suction pipe(s) and pumps the mixture into the hopper well. After some time, the hopper well is completely filled. Loading will be ceased in case overflow does not benefit overall production. Otherwise loading will continue.

In case of sandy (or coarser) soils, soil particles will settle in the hopper and the decant water with some finer particles is discharged through the commonly adjustable overflow system. When the draught of the vessel reaches the dredging loading mark or when circumstances do not allow for further loading (e.g. depth limitations), dredging will be ceased, and the suction pipe(s) hoisted on deck. Then sailing to the discharge area follows.

Sailing loaded to dumping area.

An optimum navigation route from the dredging area to the dumping area is selected based primarily on sailing distance and depth limitations. Safety, local regulations and local features are taken into account in the determination of the navigation route. This navigation route is plotted as a track in the electronic charts on board of the hoppers, allowing the hopper to closely follow this track.

Emptying hopper (discharging cargo by opening bottom valves)

When sailing to the discharge location, the sailing speed of the TSHD is gradually reduced near its destination, until the hopper comes to a full stop at the desired location. The hopper is able to keep a fixed position inside the basin, if required, by using its Dynamic Positioning (DP) system. When the hopper arrives at the discharge location, the bottom valves are opened. This technique implies an immediate discharge of the cargo. Upon completion of the discharging, the hopper is cleaned, and the bottom doors are closed before departure to the dredging /borrow location.

Surveys

The dredging activities will be surveyed on a continuous base. For the dredgers as well as for the survey vessel, all offshore survey works will be achieved using a Dynamic Global Positioning system (DGPS). Prior to all survey activities using the DGPS, the system will be checked for its integrity and reliability.

Normally the classic onshore positioning system Total station or GPS rover is used to carry out shallow water surveys. Depending on the water depth and local morphology the prism can be held by an operator on foot or on board of a shallow water vessel.

Prior to the dredging works taking place, pre-survey activities will be carried out to establish the existing topography and bathymetry. Progress survey activities will be carried out on a regular basis during the dredging works to determine the progress of the dredging activities. Once the dredging activities have been completed, post survey activities will be carried out to ascertain whether the dredging works were completed to the correct lines and levels.

Offshore surveys

To get the vertical data for each measurement two systems are basically used:

Echosounder: Data is logged directly into the system and event marks (fixes) are generated by annotator being an integral part of the echosounder. Due to motion of the survey boat (roll, pitch, heave) our data is corrected by data from a motion sensor, which is installed on the survey boat.

Tide Gauge: To reduce measured depths obtained with an echosounder to vertical values related to the local Datum, an electronic Tide Gauge is used.

A benchmark relative to the Chart Datum (CD) and correlated reference level will be established close to the tide gauge. Also close to the recording tide gauge a tide board will be installed, which will be levelled relative to this benchmark. Regular checks will be done on the tidal level transmitted to the various vessels and recorded by the tide gauge, as well as with the tide board.

By using the radio tide gauge, the tidal levels will also be received on board the dredge(s), assisting dredge equipment and the survey vessel. The tide level will be received on board the dredging vessel so that the dredging depth can be established.

Shallow Water Surveys

Trigonometric levelling: Trigonometric levelling is a standard topographic survey method and used for intertidal surveys. The level beacon can be held on foot or on board of a shallow water vessel.

Portable echo sounder: For surveys in shallow water areas, a portable echo sounder will be used on board a small boat with outboard engine.

Bathymetric Survey outcome

The bathymetric survey of berth pocket was conducted to estimate the dredge volumes. Figure 3-16 below shows the dredging area.

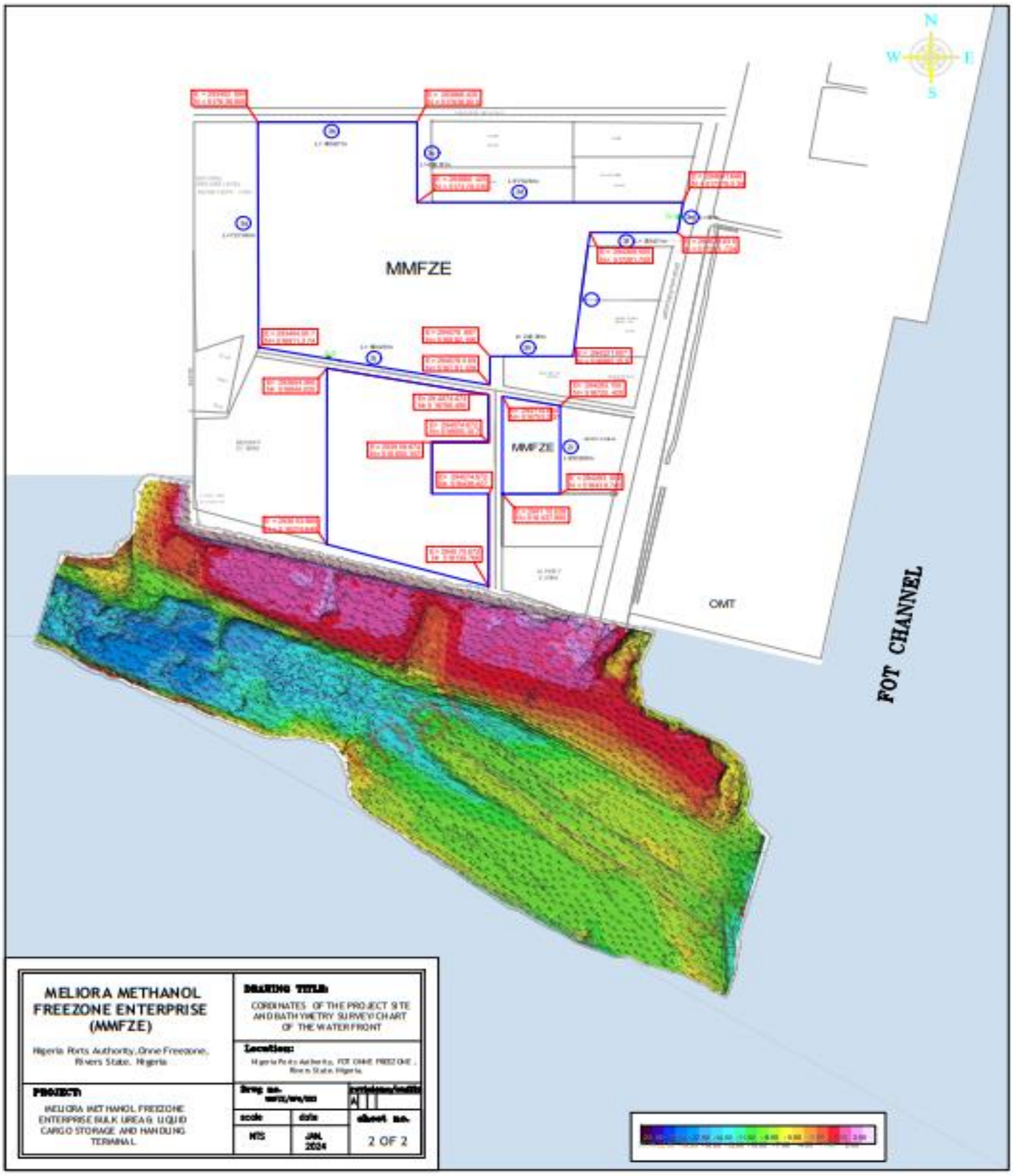


Figure 3-16: Bathymetric survey and dredging scope.

3.3.2.5 Traffic

The table below details the average traffic during construction activities.

Table 3-2: Average Traffic during Construction Phase

Sr No	Type of Vehicle	Peak Number / Day
1	Cars & Pick-ups	25
2	Minibus	10
3	Bus	2
4	Trucks Dumpers	25
5	Trailers	10
6	Concrete Trucks	25
7	Diesel Tanker	1
8	Water Tanker	1
9	Pay Loader	1
10	Excavators	2

3.3.3 Operational Phase

The operation phase will consist of the operation of the facilities described in the sections which follow.

3.3.3.1 Detailed Project Facilities and Process

The new port terminal will be used for exporting of 1.4 MMTPA Urea and 150 KTPA of Ammonia. The block process flow of Ammonia and Urea handling is shown in Figure 3-17. Brief details of the proposed facilities are mentioned below.

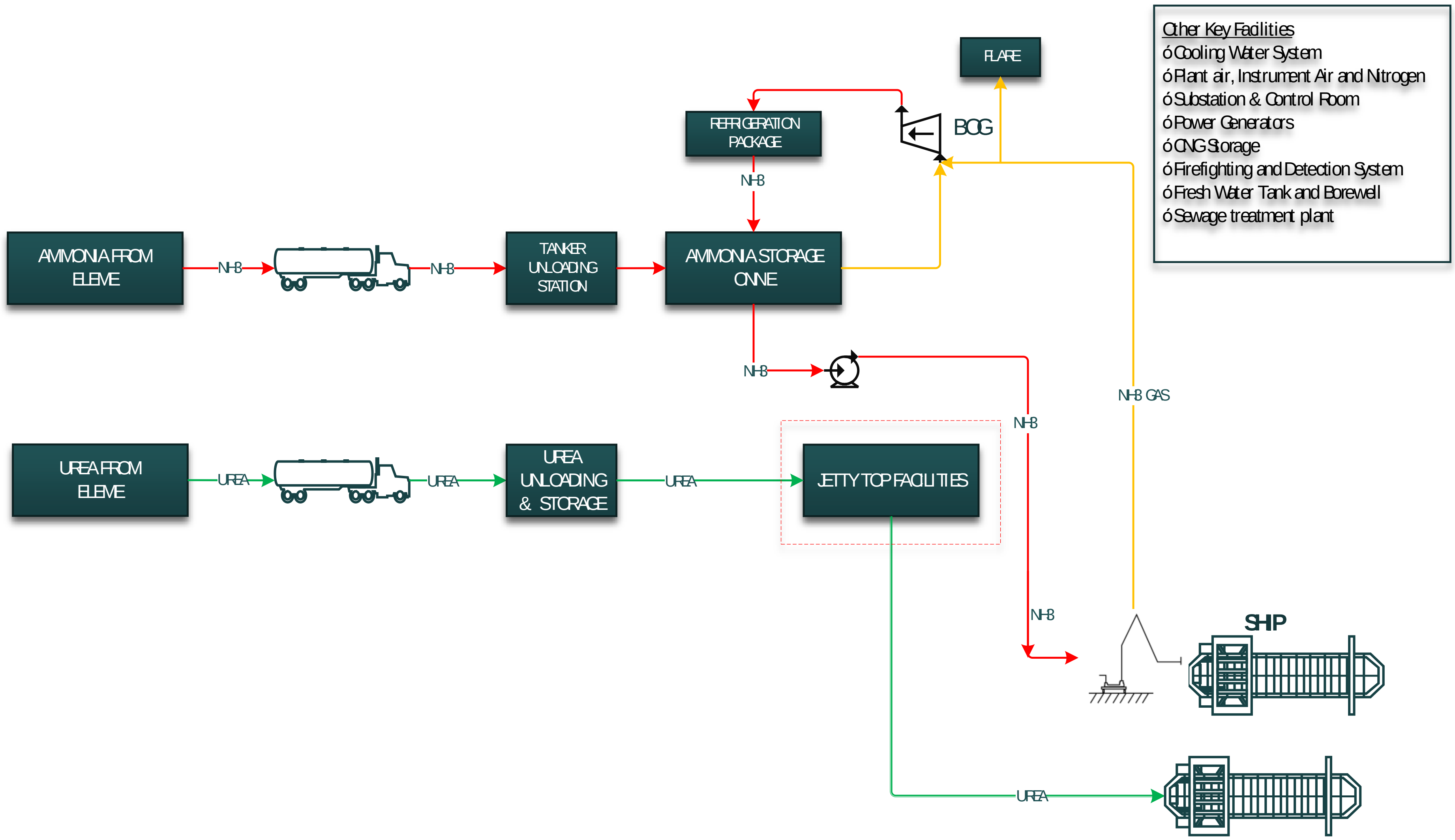


Figure 3-17: Block Process flow of Ammonia and Urea handling.

Urea Storage and Handling

Urea produced at manufacturing site will be transported to the new port terminal through covered tipper trucks having 40 Metric Tons (MT) payload capacity. Urea will be unloaded and stored in the Urea warehouse and loaded to Ultramax and Handymax bulk carriers. The Urea Storage and Handling system will have the units as detailed below.

Intake System

The Trucks Unloading Station (TUS) will consist of four truck unloading bays where the bulk urea from tipper trucks will be unloaded. The unloaded urea will pass through a grizzly (screen) and fall into underground hopper. The hopper bottom will be fitted with a belt conveyor through which the urea is conveyed to a bucket elevator. If any metallic objects are in the unloaded Urea these will be captured by the magnetic separator placed over belt conveyor. The bucket elevator will convey the urea to another belt conveyor at the top of urea warehouse. The Capacity of intake system will be 400 tons per hour (TPH).

Urea Warehouse

The urea warehouse having approximate size of 200 m x 55 m will store approximately 52,000 MT of bulk urea. The warehouse will be of prefabricated steel structure and powder coated metal sheets to protect the urea from rains. The warehouse will be equipped with a reversible shuttle conveyor which can travel along the length of the warehouse to facilitate uniform distribution and storage of the urea received from the TUS.

The warehouse will also be equipped with a portal scrapper reclaimer which can travel along the length of the storage bin, scrape the urea and pass it on to outtake conveyor during ship loading.

Finally, the warehouse will also have an Air Handling Unit (AHU) to achieve temperature control. It consists of a heating unit, blowers, and air distribution ducts to uniformly control the temperature and humidity to preserve the urea from deterioration and caking.

Outtake System

The outtake system consists of a portal scrapper reclaimer, magnetic separator, belt conveyor, belt weigh scale, transfer towers, quay conveyor (conveyor on the Quay, feeding the ship loader) and a ship loader. The quay conveyor will be designed, fabricated and installed keeping provision for installing a second ship loader in future. The capacity of outtake system will be 900 TPH.

Description of the Quay

The quay will consist of a concrete platform of 250 m x 24 m supported on piles. The quay conveyor, ship loader and other deck fittings such as fenders and bollards will be fitted on the Quay. The berth pocket in front of the quay where the vessel will be moored, will be dredged to a depth of approximately 13 m. The quay will be designed for mooring and loading of vessels having Load on Arrival (LOA) of 200 m, beam of 32 m, berthing draft of 11.50 m, maximum loaded draft of 10.50 m and a Water Line / Top of Hatch Coaming (WLTHC) of 12.5 m.

Dedusting Unit at Truck Unloading station and Outtake System

Dedusting units will be installed at TUS and outtake conveying system to capture the urea dust generated during the handling.

Ammonia Tanker Unloading Station

Ammonia produced at the manufacturing site will be transported to the new port terminal by means of dedicated tankers. The ammonia will be unloaded and stored in Ammonia Storage Tank for export.

Detailed engineering contractor (DEC) will undertake the engineering of tanker unloading station for the receipt/ unloading of liquid ammonia through International Organisation for Standardisation (ISO) tankers. The unloading station will have all facilities required to unload two tankers of approximately 20 MT capacity each, simultaneously within an hour. Details of ISO tankers will be provided by Indorama. Expected surplus liquid ammonia receipt at new port terminal will be about 420 MTPD (150 KTA).

Ammonia Storage Tank and Flare

One liquid ammonia storage tank having capacity of 25,000 MT will be installed at the new port terminal. The design of ammonia storage tank will be undertaken considering storage of ammonia at atmospheric pressure in refrigerated conditions. Accordingly, the tank will be double walled with inner insulation on the outer wall, suspended deck with construction complying with latest edition of applicable standards. The storage tank will have all necessary instrumentation, Pressure Safety Valves (connected to Flare) and controls, over pressure and vacuum protection systems as applicable in accordance with Safety Integrity Level (SIL) ratings.

Liquid ammonia will be stored at minus 33 °C. A flare stack of suitable size will be constructed near the storage tank for flaring of ammonia vapours from the storage tank and other systems in case of any need. Under normal operations there will not be any flaring.

Natural gas will be supplied to the flare stack as fuel and Liquid Petroleum Gas (LPG) manifold will be provided for alternate source.

Boil Of Gas (BOG) Unit

The ammonia vapours generated in the storage tank will be re-liquefied and sent back to tank. Towards this, a BOG unit will be installed near the Ammonia storage tank. The number and capacity of the compressor will be selected considering the minimum and maximum BOG generation scenario.

Ammonia Pumping Station from Storage Tank to Ship

The liquid Ammonia from the storage tank will be transferred to the ship via a pipeline for export. In order to pump the ammonia a pumping station with interconnecting piping, requisite instrumentation and safety systems will be installed. The pumping station will have two liquid ammonia transfer pumps each having capacity of approximately 650 T/h, considering the completion of ship loading in 36 hours.

Jetty Top Side Facilities

Loading System for Urea

The bulk urea will be loaded into the vessel by means of a travelling Ship-loader mounted on rails. The Ship-loader consists of a rail mounted travelling tripper-car housed in the quay conveyor which feeds the urea to a series of conveyors and a cascade chute through which urea gets loaded into the different hatches of the vessel without causing any damage to the urea granules. The capacity of the ship-loader will be 990 TPH.

Loading Arm for Ammonia

Ammonia loading arm will have capacity of 650 T/H to transfer liquid ammonia to the ship with adequate safety instrumentation and controls. The loading arm will be designed with Quick Release Coupling. During ship loading, the ammonia vapor generated will be sent to the Ammonia Storage BOG Unit via the Ammonia Vapor Return arm and return header. Capacity of the return arm will be designed accordingly.

Provision will be considered for cooling of loading line up to the arm. In addition, provision will be considered for depressurizing, draining, recovery and purging of loading line up to the arm.

Requirement of flow measurement and sampling point for liquid ammonia will be incorporated suitably.

The loading arms for Urea and Ammonia will be installed on the same Quay. To that extent, the ammonia loading will also be movable and will retract to the end of the quay during the loading of a Urea vessel. The operation of individual loading arm will not interfere with each other and will be operated independently.

3.3.3.2 Process Utilities

The utilities and other facilities required for the new port terminal are described in this section. Most of the utility systems will be packaged equipment.

Cooling Water System (Package Unit)

Cooling water is needed for the BOG unit and air compressors. The cooling tower will be a package unit having modular construction with Fibre-reinforced plastic (FRP) material, induced draft and evaporative type. The location will be closer to the BOG Unit.

The capacity of cooling tower and circulating pumps will be decided based on the heat load of BOG and other consumers. Suitable size of circulating water supply and return piping will be designed up to the individual equipment requiring cooling water.

To limit multiple utility packages, efforts will be made to avoid the use of cooling tower. Instead, the cooling duty will be undertaken through air coolers.

Plant Air, Instrument Air Unit (Package Unit), and Nitrogen Storage

Based on the overall requirement of Plant and Instrument air, compressors of suitable capacity will be installed. A PSA (package unit) type instrument air drier unit will be considered for generating instrument air as per the requirement.

Plant air and instrument air will be routed through individual buffer vessels having adequate hold-up volume to provide back-up during any disturbance in plant air / instrument air generation facility.

A liquid nitrogen storage of adequate capacity, equipped with vaporizer and turbocharger will be considered for supplying gaseous nitrogen. The liquid nitrogen storage will be filled by ISO – containers, therefore storage will have liquid filling arrangement. The nitrogen storage will be procured by Indorama as package.

Interconnecting piping of suitable sizes will be considered up to the individual equipment requiring these utilities.

Electrical

Power generation

The power required for the facilities / equipment at new port terminal (including power required for Urea Handling System) will be generated by means of natural gas engine driven power generation unit with associated sub-systems will be considered to meet the power requirement.

Capacity of gas engine generators will be:

- 3 units (generators) with a capacity of 1,500 Kilovolt-amps (KVA); and
- 1 unit with a capacity of 800 KVA and 1 unit with a capacity of 500 KVA.

The generating voltage will be at 3.3 Kilovolts (kV) having frequency of 50 Hz. The number of generators, capacity and generating voltage will be re-confirmed by detailed engineering contractor considering rating of the motors / other power consumers, peak and minimum power requirement for the new port terminal.

The gas engines generators will be equipped with associated sub-systems such as the synchronizing panel, generator breakers, cooling system and exhaust system.

Substation –

There will be one substation which will house all electrical systems for Ammonia and Urea Handling facility. The substation will comprise of substation building, transformers, bus bars, circuit breakers, power distribution board / panels, UPS, etc. The Sub Station building will include Air conditioning.

Power Distribution -

The generated power will be stepped down to the required voltage levels (415/230V) for further distribution to electric drives. The Substation will be designed for two (02) voltage levels, i.e., 3.3 kV and 415 volts alternating current (V AC) to cater for the power requirements of entire facility / equipment of the new port terminal.

Instrumentation /Operation Room

Operations of the entire new port terminal will be monitored from a dedicated operation room inside administrative building. The operation room will accommodate the supervisory control and data acquisition (SCADA) for Ammonia storage / handling system designed by detailed engineering contractor. The SCADA supplied by Urea storage / handling system contractor will also be housed in this room.

Utility systems, mostly being packaged units, will be controlled locally through package Programmable Logic Controller (PLC). However, certain critical parameters, alarms, operating status, Emergency Shutdown (ESD) systems of all units will be made available in the operation room for monitoring.

The closed-circuit television (CCTV), public address (PA) system, Fire & Gas detection system are in the scope of this Project. The base station of PA system, CCTVs control and monitoring, Fire & Gas detection system panel with annunciator will also be accommodated in the operation room.

Compressed Natural Gas (CNG) Storage Module

The natural gas required for power generation will be stored at high pressure in a stationary cascade at the new port terminal. The refilling of the stationary cascade will be undertaken by truck mounted mobile cascades which will transport the CNG from the manufacturing unit at Eleme to the new port terminal.

From the stationary cascades, the natural gas will be supplied to power generators after pressure reduction through de-compression station.

The stationary / mobile CNG storage modules and de-compression station will be installed to supply Natural gas to generators and Flare. Adequate redundancy will be incorporated in CNG modules to ensure consistent supply of natural gas.

Bore-Well and Water Storage, Treatment and Distribution.

Two bore-wells each having capacity of 20~25 m^3/hr will be developed at the new port terminal by Indorama for this Project. The ground water extracted by bore-well pumps will be stored in storage tank of suitable capacity. The water will be supplied to the point of use based on the requirement.

The water will be mainly required for following purposes,

- Cooling tower make-up;
- Potable water (including eye wash shower); and
- Service water (general purpose)

The estimated potable water and service water requirement of the new port terminal will be 10 m^3/day and 8 m^3/ day respectively.

Firefighting System, Fire water pumps network

Sea water will be used for the fire water requirement of the terminal. Fire water pump house will be constructed near the shoreline. Sea water will be pumped from the fire water pumping station and distributed within the new port terminal area through underground / aboveground fire water piping network.

The configuration, capacities and operating philosophy of the fire water pumping system will be decided based on the fire scenario studies of the new port terminal facilities / equipment. This study will be undertaken by a specialist fire services consultant who will provide the basic engineering documents.

Flare System for Ammonia Handling

A dedicated flare system to be installed to handle any emergency in ammonia handling system. The pressure relief valves, and other safety devices shall be designed for worst case scenarios.

Fire and Gas Detection and Protection System

Fire and Gas (including Ammonia) detection and protection systems will be considered for all facilities (excluding Urea Handling system). The fire and gas detection and protection will be a packaged system procured by Indorama.

The annunciation panel of the system will be located in the operation room.

Sewage Treatment (Package Unit)

The sewage generated in the entire new port terminal area will be appropriately treated before discharging it outside of premises. A package sewage treatment unit of suitable size will be considered for treatment and disposal.

Weigh Bridge

Two Weighbridges of 100 MT will be installed for both Incoming and Outgoing trucks.

Common Facilities at New Port Terminal

The following buildings are considered at new port terminal. The Civil design (civil outline drawing, layout, and foundation design) of these buildings is in Contractor's scope,

- Workshop / Maintenance area.
- Storage area for Oil and chemicals.
- Security Building; and
- Administration Building which will house the operation room.

The new port terminal layout detailing all the facilities and utilities in presented in Figure 3-3.

A brief summary of capacities of various facilities is given in Table 3-3 below:

Table 3-3: Capacities of the Site Facilities

No	Parameter	Unit of Measurement	Value
1	Quay length	m	300
2	Draft	m	12.5
3	Ship Size	dwt	65,000
4	Ship Loader capacity	TPH	990
5	Plot area	Hectare	20
6	Material Intake capacity	TPH	400
7	Urea Warehouse capacity	MT	52,000
8	Power generation thru Gas Engines	kVA	3 * 1500
			1*800 & 1*500
9	Urea Truck Capacity	MT	40
10	Ammonia Tanker Capacity (ISO Tankers)	MT	20
11	Ammonia Storage Tank	MT	25,000
12	Ammonia Loading Pumps	MT	2*650

No	Parameter	Unit of Measurement	Value
13	Cooling Water Package	m3/h	200
14	Plant air and Instrument Air	m3/h	200
15	Nitrogen Storage	m3	2*100

3.3.3.3 Traffic

The average amount of traffic anticipated during Project operations is detailed below.

Table 3-4: Average Traffic During Project Operations

Sr No	Type of Vehicle	Peak Number / Day
1	Cars & Pick-ups	6
2	Minibus	4
3	Bus	1
4	Urea Trucks	200
5	Trailers	1
6	Concrete Trucks	0
7	Diesel Tanker	1
8	CNG Trailer	1
Vessel Traffic		
1	Urea Vessels	3 vessels in a month
2	Ammonia Carrier	1 vessel in every two months

Where it is feasible, parks within and outside the facility will be constructed, to enable road and traffic decongestion within and around the facility.

3.3.4 Decommissioning Phase

Activities during the decommissioning phase will involve demolition and site clean-up, disposal of waste, demobilization of the workers, and a final site review. While the equipment and structures installed on the jetty that will be demolished, the jetty itself will remain. Decommissioning will take place years from now, and the baseline conditions associated with the Project and surrounds are likely to be significantly different to what it is today. When the new port terminal Project reaches end of life and should decommissioning be required then this would need to be assessed under a separate ESIA process.

3.4 Employment

Manpower plan requirement during peak time of construction will be approximately 673 national personnel and 32 expat staff. During operation phase, approximately 210 national positions will be created and 10 expat positions. Meliora Methanol FZE is committed to follow National Regulations while employing manpower and will attempt to maximize the number of locals employed.

3.5 Working Hours

Normal working hours will be 40 hours per week and 176 hours per month as stipulated by the Nigerian Labour Laws and Internal Labour Organisation (ILO) conventions.

3.6 Resources for the Project

Potential Project resources and energy requirements during construction and operation phases are presented in the tables below.

Table 3-5: Construction Phase Resources and Energy Requirements

Utilities	Source
Construction Power Supply	Will be sourced from Gas engine generators (GEG) installed at Project site
Potable Water	Will be sourced from deep borewell and shall be used after suitable treatment
Construction Materials	Like cement, steel, etc.; will be sourced from local suppliers.
Construction Water	The source of industrial water will be deep borewells
Waste Disposal Facilities	Wastes will be temporarily stored onsite before offsite disposal by government approved waste management contractors. The storm water will be checked & discharged. Waste will be disposed in accordance with National regulations.
Wastewater Treatment/Disposal	Onsite sewage treatment plant(s) will be established, and treated sewage water will be used for site application like dust suppression, irrigation etc.
Fuel	Diesel fuel shall be brought from local retailers to the site by road and will be used for refuelling of construction vehicles and machineries. For GEG, the CNG shall be sourced from existing CNG station located within Indorama Complex, Eleme.

Table 3-6: Operation Phase Resources and Energy Requirements

Utilities	Source
Electricity Supply	Will be generated by Project using Gas Engine Generators (GEG). Decompressed CNG will be used as fuel.
Potable Water	Will be sourced from deep borewell and shall be used after suitable treatment
Industrial water	The source of industrial water will be deep borewells and shall be used after appropriate treatment
Cooling Water	The source of cooling water make-up will be deep borewells and shall be used after appropriate treatment
Fire Water	The sea water will be used as fire water
Waste Disposal	Wastes will be temporarily stored onsite before offsite disposal by government approved waste management contractors.
Wastewater Treatment/ Disposal	Domestic wastewater will be treated onsite in sewage treatment plant before disposal

3.7 Emissions

The ammonia storage tanks will be designed in such a way as to minimise gaseous emissions. The ammonia storage tank will make use of flare stack. The flare stack can also be a source of gaseous emissions. A polit flame will be kept live in flare stack to ensure complete combustion of the released ammonia during emergency.

These gases will be completely combusted in flares and final release elements are combustion product of H2O and N2 etc., only.

Flare	Stack height (m)	Stack diameter (m)	Pilot Gas flow (m3/s)	Gas flow peak case (kg/hr) before burning	Gas Composition
Ammonia Storage flare	30	0.254	0.01	1000	NH3-100%

However, a closed system will be used where the vapours generated from the tank will be re-liquified and sent back to the tank, thus minimising emissions released into the atmosphere. Other emissions include dust emissions during the construction activities, which are of a temporary nature and the emissions from Natural Gas (NG) fired power generating engines.

3.8 Wastes

Wastes generated from Project activities can be categorised as non-hazardous or hazardous according to their types and associated risks. The definitions of waste categories are as follows:

- **Non-hazardous Wastes** – wastes that do not exhibit any hazardous properties and are relatively low risk to human health and the environment. This category would include a range of materials that may be recycled or can safely be disposed of in a landfill.
- **Hazardous Wastes** – wastes that exhibit one or more characteristics which mean that the wastes are potentially harmful to human health and/or can cause damage to the environment (air, land, and/or water) or natural ecosystems. For example, the waste may be corrosive, reactive, toxic, mutagenic, teratogenic, infectious, carcinogenic, ecotoxic, flammable, or explosive.

3.8.1 Construction Phase

Waste is anticipated to be generated during the construction phase is detailed below:

Spoil from the dredging works: Construction the jetty will require dredging works using a CSD and THSD. The dredged material to the volume of approximately 2,000,000m^3, is anticipated to be dumped according to MARPOL 73/78 regulations, Nigerian standards, the NPA and waste disposal best practice.

The estimated quantities of other wastes expected to generate during construction and operation phase along with disposal methods are presented in below table 3-7. The waste generated from various activities will be segregated at source and stored in dedicated bins / storage area before disposal.

Table 3-7: Estimated Waste Generation and disposal methods

Waste	Est. Vol/wt	Disposal methods
Solid		
Bentonite used for bored cast-in place Concrete piles for quay	20 Tons	Overflowing Bentonite will be collected /contained in tanks. It will be sundried and disposed as filling material within the project site.
Empty oil /chemical containers	500kg/month – Construction period 100kg/month – Operation period	Containers shall be properly washed, detoxified, and cleaned of residues before being re-used. It may also be crushed and recycled after washing
Maintenance wastes (oil and fuel/diesel filter, wires etc.)	100kg/month – construction period 100kg/month – construction period	Collect in designated bins and transport to recycling unit / facilities
Food wastes	25kg/day – Operations	Segregate and disposed in government approved dump sites
Metal scraps, broken tools, rag, old parts, etc.	50MT during construction 1,500kg/Month – Operations	Stored in skips, segregated, and recycled for future use
Plastic bins and containers	20kg/Month – Operations	Segregated, washed, and re-used, or may be sold.
Floor swipe urea	200 MT/year - Operations	Collected and send back for recycling
Fluorescent bulbs Used batteries etc.	–	Crushed/dismantle and sold to recycler / vendors
Liquid		
Sewage wastewater	20kl/day design	STP will be installed within the Jetty for treatment before disposal.
Ballast water	Cannot estimate at this time	Treated appropriately before disposal through MARPOL contractor
Used lube/engine oils	500 liter/year	Stored in carboys and sent to recycling units
Storm water	20cm/day (dry) & 450cm/day (wet) Season.	Storm water from areas prone to urea spillage will be collected in pit and shall be disposed after checking for quality.
Lube oil, seal and hydraulic oil spills/residuals, and diesel fuel residuals from Dredger	1,000liter during construction	Stored in carboys and sent to recycling units

3.8.2 Operation Phase

3.8.2.1 Hydrocarbon spillages

Operational waste includes possible hydrocarbon spillages from vessels during export activities. An offshore and onshore Waste Management Plan (WMP) will be implemented as part of the installation as well as operation activities. Waste management during the project activities will comply with applicable Nigerian legislation and The International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78.

3.8.2.2 Food Waste

Where permitted under MARPOL 73/78 Annex V, food waste may be discharged at sea. Ground or crushed food wate is permitted for discharge at more than 3 nautical miles from the nearest land. Non ground or crushed food wate is permitted for discharge at more than 12 nautical miles from the nearest land.

3.8.2.3 Sewage Treatment Plant

A 20 Kilo liters per day (KLD) package sewage treatment plant will be installed to effectively treat the sewage effluent generated from office activities. The treated sewage effluent will be discharged to nearby Bonny channel and as per National Regulations a required permit will be secured from the Federal Ministry of Environment (FMEnv). The design criteria considered are shown in the table below. The treated sewage water quality conforms to the FMEnv and IFC standards.

Table 3-7: Design Criteria of STP

Sewage Water		Treated Water		FMEnv Limit*	IFC Limit
Parameter	Status	Parameter	Condition		
pH	6.0 to 8	pH	6.5 - 8.5	6.0 - 8.5	6 - 9
BOD (ppm)	150-300	BOD (ppm)	Max 30	30	30
COD (ppm)	350-550	COD (ppm)	Max 80	90	125
TSS (ppm)	200	TSS (ppm)	Max 30	30	50
Oil & grease (ppm)	30	Oil & grease	<10	<10	<10
Total coliform bacteria (MPN/100ml)	1000	Total coliform bacteria	Max 100	100	400

**FMEnv: Refers to Treated Wastewater.*

The technology of the STP works on the principles of bioreactor which allows the spontaneous fixing of the biomass on particle. The reactor creates a large bio-film liquid interfacial area, high interfacial velocities, and good mass transfer characteristics. The features of the Bio-mass Reactor Technology are:

- Self-regulating with operational adjustments required.
- No sludge recirculation
- Single pass treatment
- Lower footprints than any other technology
- Stable under high organic loading
- Low mechanical equipment maintenance
- Low noise level since blowers are enclosed in container.
- No odor in surrounding environment
- Stable nutrients removal

- Capacity to handle Biomass of more than 15000 to 20000 mg/liter available for efficient treatment thus ensuring Nitrogen and Phosphorus removals.
- No media replacement
- Plant is coated internally with paints / Coal tar epoxy internally and externally with Polyurethane paint to withstand and climate condition of the site.

Sewage Treatment Process

Wastewater generated from toilets, bathrooms and kitchens will be collected via a series of drainpipes and finally will be collected in a sewage collection tank which is fully enclosed and covered with a slab. Oil and grease traps will be provided in a collection tank. Treatment of collected sewage will follow the following treatment process.

Screening

Solid particles such as clothes, plastics etc. are trapped in bar screens and removed manually with the help of spade. Screens are cleaned regularly to avoid any blockages. Screened matter will be collected and stored in drum for disposal.

Sewage Transfer to Aerobic Fluidized Media Bio Reactor

Two submersible sewage pumps (operated with help of level controller) of suitable KLPH @ 10mtr head capacity are provided in sewage collection tank. This pump steadily delivers wastewater into an aerobic bio reactor where a huge consortium of active biomass is maintained with help of specially designed PP non-clog cubes which provides high surface area for biomass development. Oxygen required for biomass development is provided with the help of twin lobe air blowers (1working + 1 standby). In Mixed Bed Bio Reactor / Fixed Bed Bio Reactor (FBBR/ MBBR) biomass in the range of 20 to 30Kg/m3 is maintained in contrast to only 3 to 5 kg /m3 which available is in suspended activated sludge process. Due to such a higher concentration of biomass available, treatment of wastewater is achieved with minimum retention time of 2 hours which otherwise would require 5 to 6 hours. These microorganisms consume the organic matter present in sewage and reproduce.

Since most of the biomass is attached on the media, sludge formation from this process is minimum and also Sludge recirculation is not required. Overflow from the FBBR is discharged at the bottom of the lamella clarifier.

Flocculation & Clarification of Biomass

In lamella clarifier solid particles get collected in deep hopper and are removed on inbuilt sludge drying bed where it gets de-watered. Clarified wastewater is then discharged into filter feed sump.

Sludge Handling & Disposal

Sludge from lamella clarifier is removed periodically on inbuilt drying bed. Dewatered sludge is sundried and is used as manure for gardening.

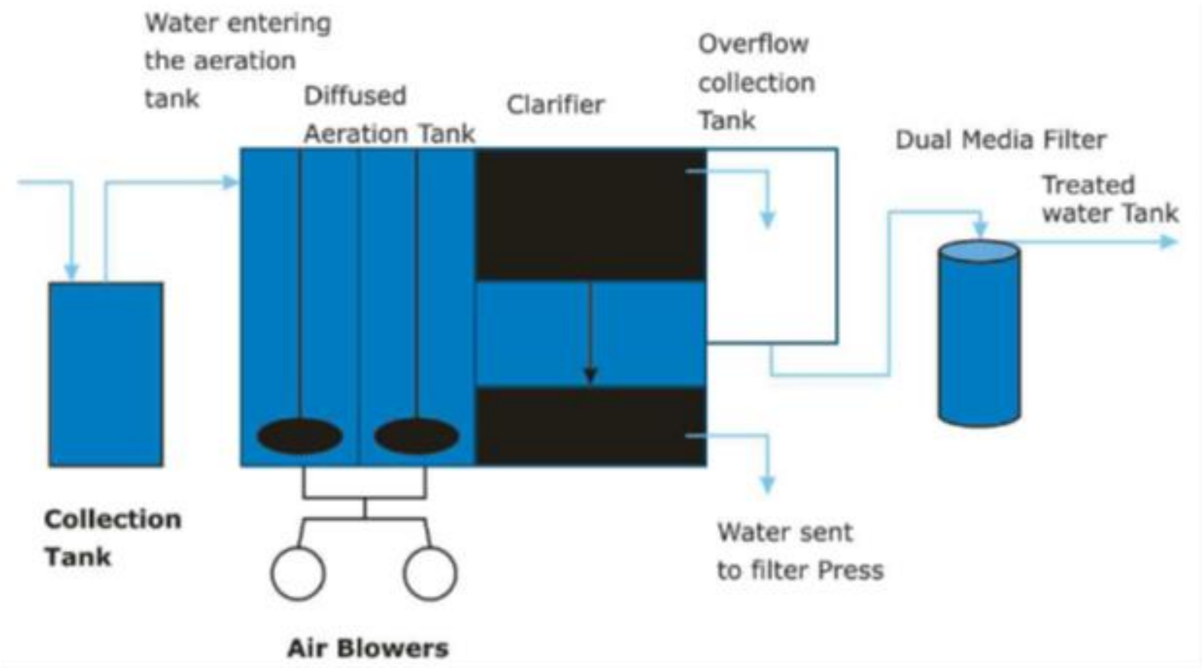


Figure 3-18: STP Process flow Diagram.

3.9 Energy Management

Gas Engin Generators (GEG) will be used as an energy source during Project activities. Compressed Natural Gas (CNG) will be used for fuel. IEFCL have considered the guidelines included in the IFC General EHS Guidelines (Energy Conservation) and Industry Specific Guidelines where energy conservation is concerned.

3.10 Stormwater Management

Stormwater will be managed in the same manner as proposed for the Train 3 Project, which will include following recommendations indicated by the WBG General EHS Guidelines on Wastewater and Ambient Water Quality (2007).

Stormwater includes any surface runoff and flows resulting from precipitation, drainage, or other sources. In order to reduce the need for stormwater treatment, the following principles, in compliance with IFC guidelines on Wastewater and Ambient water quality will be applied for the Project.

- Stormwater will be separated from process and sanitary wastewater streams to reduce the volume of wastewater to be treated prior to discharge.
- Surface runoff from process areas or potential sources of contamination will be prevented. Where this approach is not practical, runoff from process and storage areas will be segregated from potentially less contaminated runoff.
- Runoff from areas without potential sources of contamination should be minimised (e.g., by minimising the area of impermeable surfaces) and the peak discharge rate should be reduced (e.g., by using vegetated swales and retention ponds).

- Where stormwater treatment is deemed necessary to protect the quality of receiving water bodies, priority will be given to managing and treating the first flush of stormwater runoff where the majority of potential contaminants tend to be present. Normal case will consider the disposal of neutralized wastewater and of de-oiled storm water to the existing plant pond.
- Oil water separators and grease traps will be installed and maintained as appropriate at refuelling facilities, workshops, parking areas, fuel storage and containment areas. Oil Skimmer has been foreseen inside each first rain sump to remove the majority of the oil, while the remaining will be removed through a Coalescing Plate Separator.
- Sludge from stormwater catchments or collection and treatment systems may contain elevated levels of pollutants and should be disposed in compliance with local regulatory requirements, in the absence of which disposal has to be consistent with protection of public health and safety, and conservation and long-term sustainability of water and land resources. Organic sludge will be incinerated in existing incinerators following existing SOP and ash will be analysed as TCLP (Toxicity characteristics leaching procedure). Any spent catalyst containing zinc Sulphide will be handled by competent person as per the guidelines of MSDS HSE (Health safety and Environment) procedure.

3.11 Project Schedule

The construction phase will not commence prior to the approval of the ESIA study. It is assumed that construction will continue for a duration of approximately 22 months. It should be noted that no construction activities will be undertaken during the night.

Early estimates indicate a potential life of the plant of approximately 30 years of operation. Given that the new port terminal is proposed to be in service of the plant, the export activities associated with the urea and ammonia are directly linked to the life of the plant.

The project construction is expected to start during month of June’2024 and project commissioning is expected during month of April’2026. The project schedule is presented in below figure 3-19.

Sr. No.	Activity	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28
		Jan'24	Feb'24	Mar'24	Apr'24	May'24	Jun'24	Jul'24	Aug'24	Sep'24	Oct'24	Nov'24	Dec'24	Jan'25	Feb'25	Mar'25	Apr'25	May'25	Jun'25	Jul'25	Aug'25	Sep'25	Oct'25	Nov'25	Dec'25	Jan'26	Feb'26	Mar'26	Apr'26
A	**ENGINEERING**																												
	Marine Works																												
	Urea Storage Building																												
	Truck Unloading Station																												
	Electrical Substation																												
	Administration & Control Building																												
	Area Drainage																												
	Sewage Treatment Plant																												
	Main Stores																												
B	**PROCUREMENT**																												
	Material Handling System																												
	Generators																												
	Air Handing Units																												
	Dedusting System																												
	Electrical Items																												
C	**CONSTRUCTION**																												
	Marine Works																												
	Piling & Diaphragm Wall																												
	Quay Deck																												
	Dredging																												
	Deck Fixtures																												
	Urea Storage Building																												
	Ground Improvements																												
	Foundation																												
	Erection of PEB																												
	Truck Unloading Station																												
	Cofferdam -Diaphragm Wall																												
	Foundation																												
	Erection of PEB																												
	Electrical Substation																												
	Foundation																												
	Superstructure																												
	Installation of DG/CNG Generators																												
	Administration & Control Building																												
	Foundation																												
	Superstructure																												
	Finishing & Interiors																												
	Main Stores																												
	Foundation																												
	Erection of PEB																												
	Area Drainage																												
	Sewage Treatment Plant																												
	Erection of Material Handling System																												
D	**COMMISSIONING**																												
	Precommissioning																												
	Commissioning																												

Figure 3-19: Project Schedule

CHAPTER – FOUR

4. DESCRIPTION OF THE ENVIRONMENT

4.1 Introduction

This Chapter provides an understanding of the physical, biological, and social attributes of the area in which the MM FZE Terminal Project is proposed and its surroundings. The description of the baseline environment is essential in that it represents the conditions before the construction of the proposed Project. The description of the baseline environment therefore provides a description of the current or status quo environment against which social and environmental impacts of the proposed MM FZE Project are assessed, and future changes monitored.

4.2 Study Area and Area of Influence

For the characterisation of the physical, biological, and socio-economic baseline and associated impact assessments presented in *Chapter 5,* the definitions applicable to the Project Area are as follows:

- **Project Area** – is defined as the MM FZE Terminal Project which borders undeveloped land to the north and east, Operational Onne Multipurpose Terminal (OMT) on west and have waterfront of approximately 400 m to the south. The Project footprint will be 20 hectares (ha) that will house Urea storage and handling system, Ammonia storage and handling system and associated facilities detailed in the *Section 3.3.1.*
- **Study Area** - the Study Area (or Area of Influence) is defined as the area likely to be affected by the Project activities during construction, operational and decommissioning phases. The Study Area includes:
  - The primary Project site and related facilities that MM FZE develops or controls.
  - Additional areas in which aspects of the environment could conceivably experience significant impacts.
  - Areas potentially affected by cumulative impacts resulting from other potential or known developments at the time of the ESIA, further planned phases of the Project and/or any other existing circumstances.
  - Areas potentially affected by impacts from predictable (but unplanned) developments as a result of the Project (i.e., induced activities), occurring at a later stage or at a different location.

The study specific definitions for Study Area are provided in each aspect investigated (viz. air quality, noise, biodiversity, socio-economic, etc.).

4.3 Baseline Data

The information relating to this *Chapter* has been sourced from baseline data collected by ECSL in the months of June and July 2023 following commissioning by MM FZE. Some of the studies like as surface and ground water quality assessment and water birds survey conducted in the month of January 2024 is also included in this revised report. ECSL is a FMEnv accredited Nigerian E&S consultant that carried out baseline data collection under the supervision of FMEnv. The RSMEnv and NPA representatives also participated in the baseline data collection exercise. ERM undertook a review and gap analysis / quality assurance of the wet season baseline data collected in June and July 2023 against the requirements of the IFC PSs. The quality assurance was undertaken with the intention of identifying whether further action would be required to address any gaps.

Majority of the gaps identified were addressed through clarification/provision of additional information from MM FZE. However, given the timeframes associated with the overall Project, it was not possible to collect and include certain baseline data/information for dry season as part of the ESIA process. As such, actions to close out such gaps have been included as post-ESIA commitments and included in the associated ESMMP, however the surface water and groundwater quality assessment and water bird survey was conducted in the month of January 2024 and has been included in this revised report.

Data presented by the wet and dry season baseline assessments have been cross-referenced with publicly available online data where possible.

The Sections included in this Chapter are organised into a description of physical environment (Section 4.4, Biophysical Environment (Section 4.5), Socio-Economic Environment (including health) (Section 4.6), Cultural Heritage (Section 4.7), Traffic (Section 4.8) and Stakeholder Engagement (Section 4.9). The methodologies employed in collecting baseline data have been highlighted under each Sub-section.

4.4 Physical Environment

This *Section* provides the baseline environmental conditions for the physical environment. It covers meteorology and climate, air quality, Greenhouse Gases (GHG) emissions, surface and groundwater, sediments, noise, geology, soils, and land use.

4.4.1 Meteorology and Climate

4.4.1.1 Overview of the Climate

Nigeria is characterised by the following distinct climatic zones: a tropical wet climate in the south, a tropical savannah climate for most of the central regions, and a Sahelian hot and semi-arid climate in the north of the Country. The Project falls within the tropical wet climatic zone. In the Project location, the mean annual temperature ranges between 17°C to 37°C. During the dry season, Harmattan winds bring dry air from the Sahara Desert to Nigeria, while during the rainy season moist air is brought from the Atlantic Ocean (USAID, 2019).

4.4.1.2 Methodology for Meteorological data collection

The field diurnal meteorological parameters at the proposed project site were measured and recorded from the 3rd of July to 20th of July 2023. The methodology adopted and employed for meteorological assessment and monitoring was in compliance with standard norms laid down by the Nigerian Meteorological Agency (NiMet). Furthermore, a five year (January 2018 to Dec 2022) historical meteorological data were obtained from National Aeronautics and Space Administration (NASA). Long term (30-year) meteorological data was obtained from NiMet for Port Harcourt Station. The micro-meteorological parameters assessed in the project area were temperature, humidity, rainfall, wind speed, barometric air pressure, clod cover and wind direction as presented in **Annexure 4.1.**

4.4.1.3 Rainfall

The Project Area falls within the tropical wet (monsoon) climatic zone. The annual distribution of rainfall in this climatic zone is characterised by two distinct seasons: wet season that runs from mid-March through to November and a dry season that runs from December through to March. The daily rainfall values measured at the proposed project area ranged from 8.2mm to 68.4mm; while the monthly mean values of the secondary data ranged from 21.44mm to 431.34mmm (Figure 4-1). The 30 years (1990-2020) secondary data of the proposed project area shows that monthly rainfall between May and October averages over 300 mm, while the monthly averages during the dry season are below 40 mm. The highest precipitation is experienced in September at 374.5 mm, while the lowest is experienced in January at 21.4 mm while historical data from 1990-2020 show average rainfall of 20.4mm for December (Table 4.1a). Rainfall in the area is expected to play a significant role in atmospheric wash-out of dissolved air pollutants.

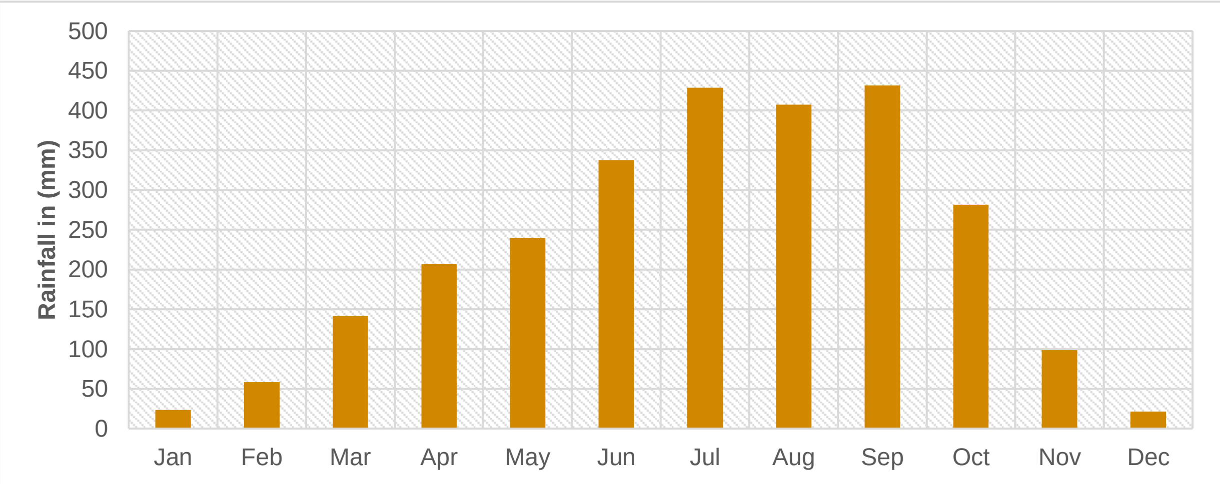


Figure 4-1: Monthly Rainfall Distribution in the Study Area.

Source: Average Weather in the project area (2018-2022) MM Port FZE meteorological report

4.4.1.4 Air Temperature

The most significant temperature differences in Nigeria are: (I) between the coastal areas and its interior; and (ii) between the plateau and the lowlands. On the plateau, the mean annual temperature varies between 21°C and 27°C, whereas in the interior lowlands, temperatures are generally over 27°C. The coastal fringes have lower temperature averages than the interior lowlands. Seasonal mean temperatures are consistently over 20°C throughout the country and diurnal variations are more pronounced than seasonal ones. Highest temperatures occur during the dry season with minimal variations from the coast to inland areas.

For the Project Area, Figure 4-2 below indicates that the months of July to September for the years 2018-2022 recorded slightly lower temperatures (27°C) due to rainy periods, while the months of

November to March within the same period recorded higher temperatures (29-30°C)[1], due to increased solar radiation with low cloud cover dominant during the dry season. During hotter days, evapotranspiration creates a cooling effect that lowers surface temperature.

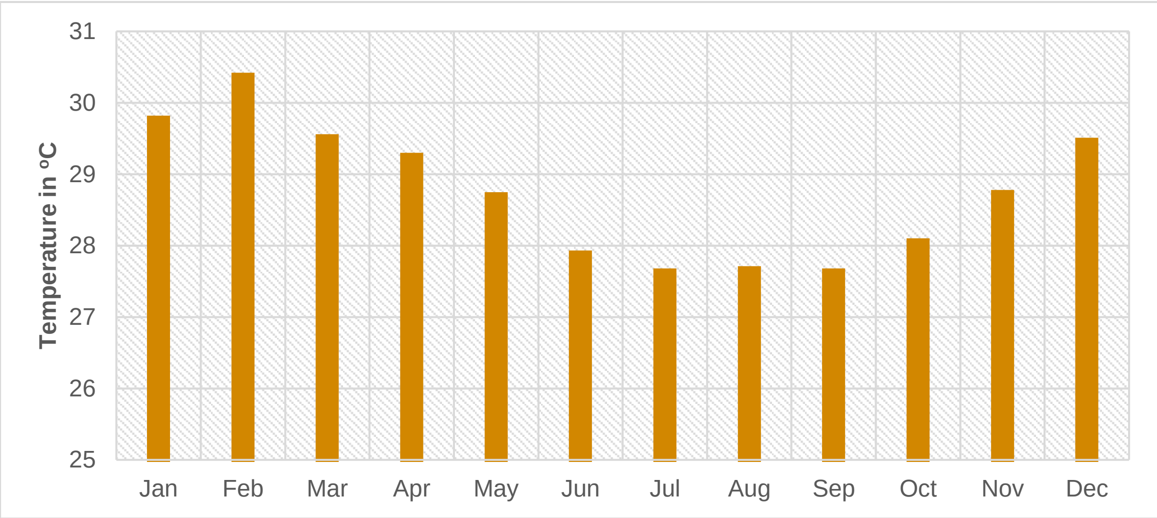


Figure 4-2: Mean Monthly Temperature in ^{0}C.

Source: Average Weather in the project area (2018-2022) MM Port FZE meteorological report

4.4.1.5 Relative Humidity

According to secondary data obtained for the project site from the year 2018 to 2022, humidity ranged from 60.12% to 96.12% with a mean deviation of 88.92±4.98%. Monthly analysis of the secondary data indicates that mean relative humidity was minimum (82.97%) in January and maximum (91.58%) in September which corresponds to the driest and the wettest months as per Figure 4-1. Furthermore, field data collected between 3rd July and 20July 2023 revealed that humidity values oscillate in tandem with air temperature, but as opposite fluxes as shown in Figure 4-3 (Yorkor et al., 2017). High relative humidity of this nature is expected in the project environment due to continuous complete cloud cover and prolong heavy precipitation in the rainy season (Yorkor et al., 2017). The variation of mean relative humidity in project area during field measurement is shown in Figure 4-3

4.4.1.6 Wind Speed and Direction

The result obtained during field monitoring that was undertaken in July 2023 indicated temperate wind speeds around the proposed project area ranging from 0.75m/s to 2.98m/s. The wind roses show the general wind direction and wind speed for each sampling period. The field data wind rose shows that during this particular sampling period the wind blew from the southwest 29.7% of the time, while the secondary data wind rose (Figure 4-4) shows that the wind blew from southwest 21.3%, from the south 8.5% and the northeast 4.25% of the time. The statistical analysis of the secondary data obtained for the years 2018 to 2022 (f indicates the prevalence northeast (NE) wind in the dry season months (January, February, and December); while southwest (SW) wind prevails in the rainy season months. The analysis of both the field and the secondary data shows the dominance of south-westerly (SW) wind in the area, which can be attributed to the long period of rainy season that characterize the area.

[1][1]MM Port FZE meteorological report

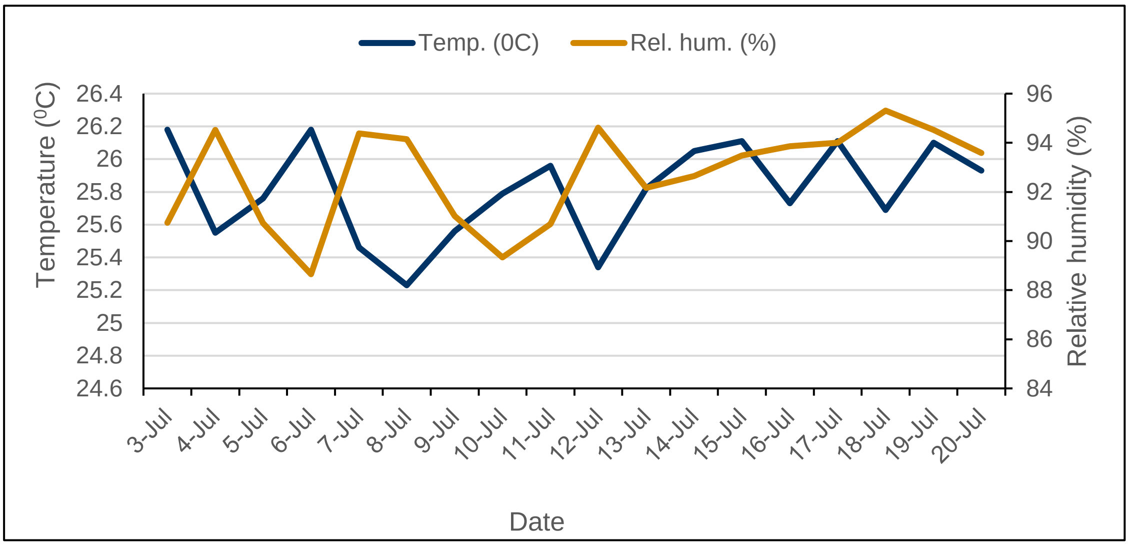


Figure 4-3: Daily Average Diurnal Temperature and Relative Humidity (July 3 – July 20, 2023).

Source: MM Port FZE meteorological report.

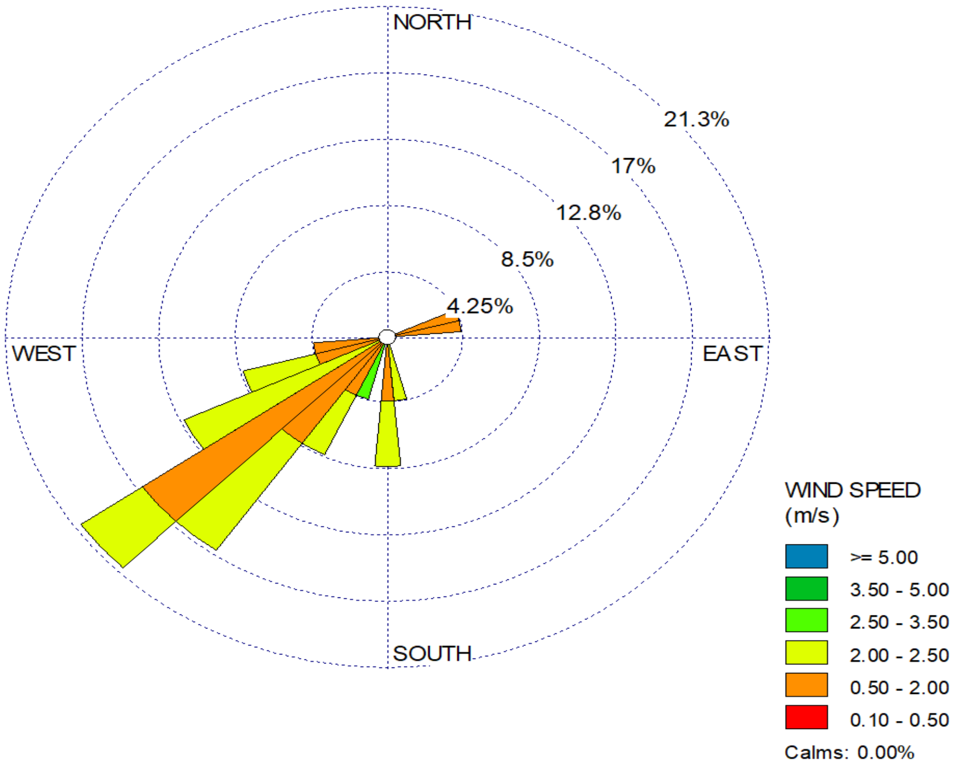


Figure 4-4: Wind rose of secondary meteorological data (2018 – 2022).

Source: Meteorological Report MM Port FZE

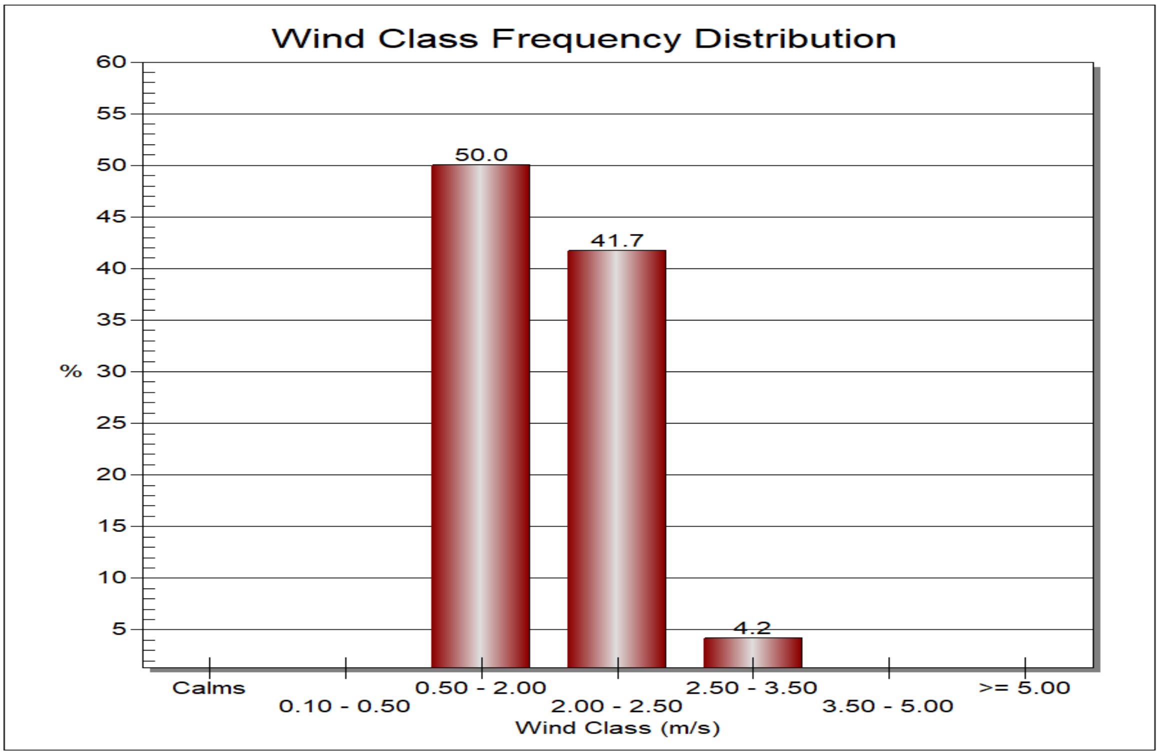


Figure 4-5: Wind Class of Secondary Meteorological Data (2018 – 2022).

Source: Meteorological Report MM Port FZE

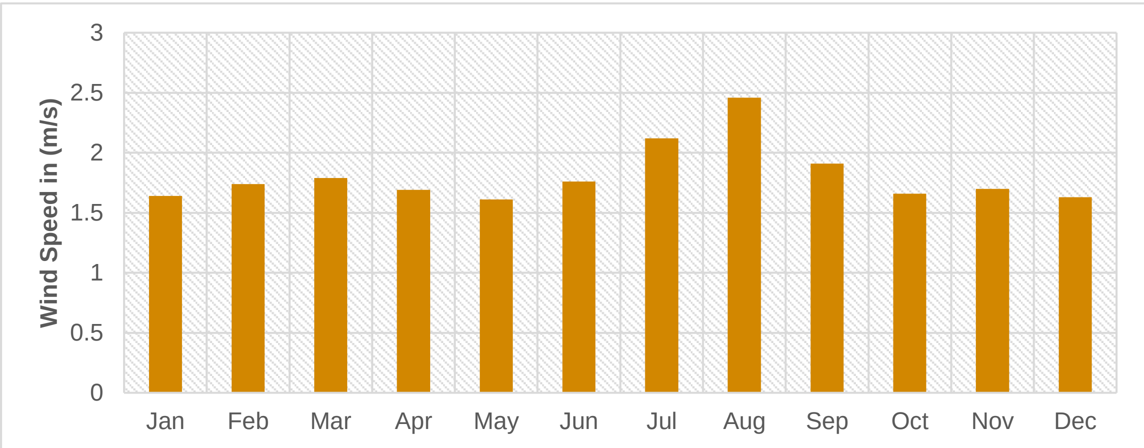


Figure 4-6: Average Monthly Wind Speed for Port Harcourt (2018 – 2022).

Source: Meteorological Report MM Port FZE

4.4.1.7 Cloud Cover

During field monitoring in July 2023, a cloudy weather condition was observed in the proposed project area in day hours. The observed cloud covers ranged between 5 and 8 Oktas, with average values between 6 and 7.5Oktas[2]. The report found out that a lofty cloudy weather of this nature is a common characteristic of the proposed project area during the months of rainy season. Due to the high cloud cover, the temperature of the atmosphere falls at a rate greater than adiabatic lapse rate. This tends to

[2] Meteorology / Climate Report for MM Port FZE Project ESIA

suppress unstable atmosphere which enhances air emission dispersions. Sunny days characterize the dry season and hence minimal cloud cover (Figure 4-7). Lower cloud cover in the dry season encourages unstable atmospheric conditions that promotes atmospheric emission dispersions.

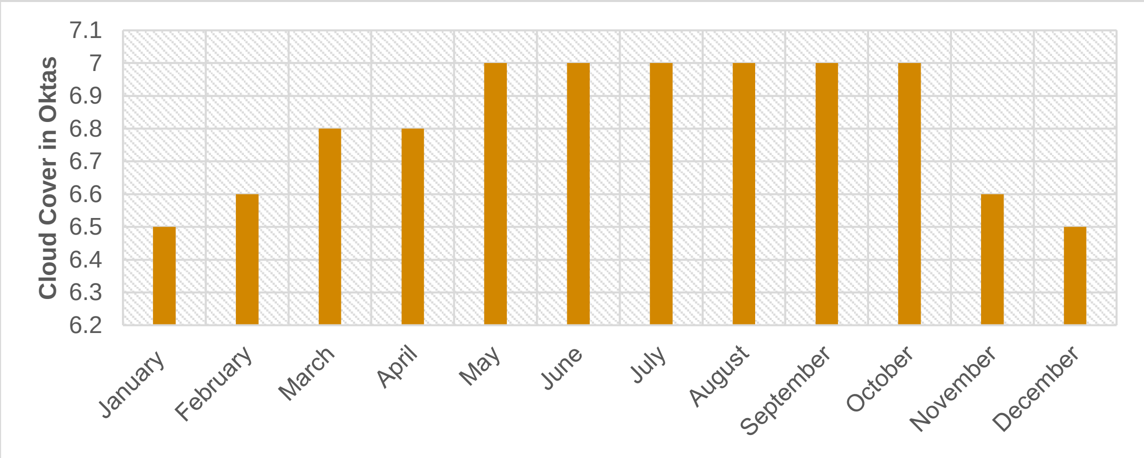


Figure 4-7: Average Monthly Cloud Cover in the Project Area.

Source: Average Weather Trend for Port Harcourt (1990-2020), NIMET[3], Port Harcourt

Table 4.1a Average Weather Trend for Port Harcourt (1990-2020)

S/No	Month	Average Temp (^{0}C)	Rainfall (mm)	Cloud Cover (oktas)	Pressure (mbar)	R/H (%)	Wind Speed (m/s)	Prominent Wind Dir.
1	January	33.5	17.2	6.5	1007	74	2.9	NE
2	February	34.2	76.5	6.6	1007	79	2.8	SW
3	March	33.8	95.2	6.8	1006	83	3.6	SW
4	April	31.7	144.1	6.8	1007	83	3.7	SW
5	May	31.9	248.4	7	1007	87	3.8	SW
6	June	30.3	312.2	7	1009	91	3.9	SW
7	July	28.1	368.0	7	1010	92	4.3	SW
8	August	28.6	325.2	7	1010	92	4.3	SW
9	September	28.3	374.5	7	1009	92	4.4	SW
10	October	30.8	241.9	7	1009	89	3.8	SW
11	November	32.4	74.0	6.6	1007	84	2.9	SW
12	December	33.4	20.4	6.5	1007	73	2.6	NE

Source: NIMET, Port Harcourt

4.4.2 Climate Risks

4.4.2.1 Introduction

The potential physical impacts that climate change could have on the Project have been considered in this *Section*. This has been undertaken through a high-level scenario analysis, which has assessed the

[3] Home - Nigerian Meteorological Agency (nimet.gov.ng)

impact of climate change on physical climate-related risks associated with a full list of ERM's identified hazard types (extreme heat, extreme cold, flooding, landslides, wildfires, coastal flooding, water stress & drought and tropical cyclones) in relation to the proposed Project. Only those hazards deemed applicable to the Project have been assessed.

The scenario analysis has utilised a range of the Intergovernmental Panel on Climate Change (IPCC) climate change scenarios under a range of future projected time horizons (2030 and 2050) – which have been selected based upon their relevance to the Project and in alignment with the guidance set out by the Task Force on Climate-Related Financial Disclosures (TCFD). This includes SSP1-2.6[4], which is most closely aligned with the targets made under the Paris Agreement (to aim to keep temperatures increases by 2100 at 2 ^{0}C or lower) and SSP5-8.5[5], which is a higher emissions scenario, also referred to as the Business-as-Usual scenario. As a part of this scenario analysis, climate-related risks have been identified under future projected timeframes and scenarios.

The Climate Change Risk Assessment (CCRA) Baseline Data below is for the current and 2030-time horizon which is provided as an insight to the possible climate trends for the construction stage and beginning of the operation stage.

The CCRA Future Climate Projections (Predictions) and risk scores are presented in Section 4.4.2.3 for the future and 2050 period which are used to provide insight to the climate trends towards the later stages of the operational phase.

4.4.2.2 Literature review

Research from USAID (2019) suggests that by 2060, Nigeria's average temperatures may increase between 1.1°C and 2.5°C, with higher rates of warming in the north. Rainfall variability and extreme rainfall events are also projected to increase across most of the country. Coastal areas are expected to experience an increase of 0.4-1.0m in mean sea level by 2100. In addition, there is a projection that the number of cold nights will decrease drastically, even with a projection of close to zero by 2090 while the number of extreme heat days is projected to increase by 2100 to 260 days (it was 10 days in 1990).

The World Bank Group (WBG) (2021) project that temperatures will increase across the country progressively through to the end of the century, with a potential increase in temperatures of between 2.9°C with up to 5.7°C, coupled with an increase in low temperatures and average temperatures are also expected to increase. Night-time temperatures are expected to increase by 4.7°C. By the 2100s, it is expected that the duration of heat waves will increase by an additional 8 to 55 days.

Additionally, there is a projection of heavy rainfall intensifying, plus, during the summer rainy seasons flooding events due to extreme rainfall, precipitation events and extreme events are expected to impact surface water runoff and rivers. This plus an increase in the intensity and frequency of droughts may lead to an increase in natural disasters. Precipitation quantities are most likely to increase from the end

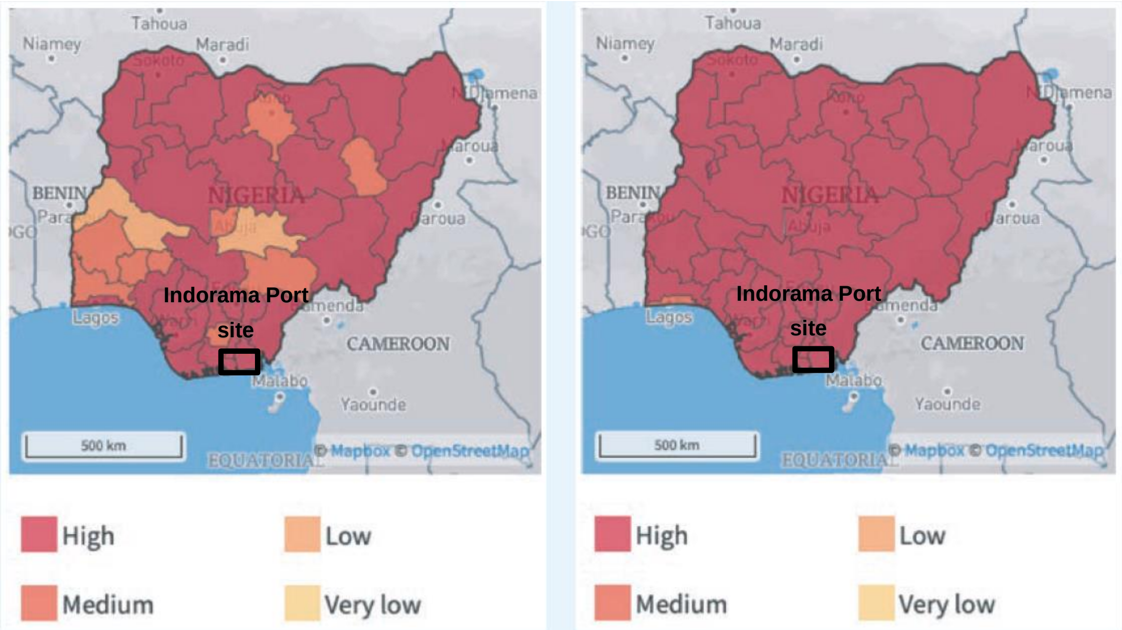
[4] Shared Socio-economic Pathways (SSPs) are scenarios of projected socio-economic global changes up to the year 2100. These scenarios are used to derive greenhouse gas emissions scenarios with different climate policies. SSP1-2.6 is a scenario that assumes low GHG emissions (i.e. CO_2 emissions are reduced to net zero by 2075).

[5] SSP5-8.5 scenario assumes very high GHG emissions (i.e. – that CO_2 emissions will triple by 2075).

of the rainy season up until the start of the dry season, which will be from September up until December (The World Bank Group, 2021).

"*Nigeria is at risk to numerous natural hazards and prone to floods, storms, ocean surges, droughts, and wildfires. Nigeria's coastal states face extensive risks from storm surge along the entire coast, and inland flooding and wildfires in the Niger Delta region, and negative rainfall anomalies in the southeast*" (WBG, 2021, pg 11). See

The Project Area falls within High Risk for both aspects of Flooding and Wildfires (Figure 4-8)



Source: The World Bank Group, 2021

Figure 4-8: Nigeria's Risk of Urban Flood (left) and Risk of Wildfire (right).

The WRI Aqueduct offer projections for 2030 and 2050 under a pessimistic[6] scenario. Results for the Project for drought risk / the projected change in water stress[7] is shown in Table 4-1b.

Table 4-1b: Projected Water Stress for Indorama Port.

Climate Variable / Event	Projection
Drought Risk / Water Stress	2030: Low (<10%) water stress 2050: Low (<10%) water stress

[6] *The "pessimistic" scenario (SSP5 RCP8.5) represents a future where temperatures increase up to 3.3°C to 5.7°C by 2100. SSP5 describes fossil-fueled development: rapid economic growth and globalization powered by carbon-intensive energy, strong institutions with high investment in education and technology but a lack of global environmental concern, and the population peaking and declining in the 21st century.*

[7] *Water stress is an indicator of competition for water resources and is defined informally as the ratio of demand for water by human society divided by available water." (WRI Aqueduct, 2023)*

Source: WRI (Aqueduct)

Figure 4-9: Projected Water Stress for Indorama Port (2030 & 2050).

4.4.2.3 Risk Scores

Coastal Flood Risk

The Coastal flood risk for MM FZE Port is at 'Extremely High (more than 2 in 1,000)' as the location falls within the Niger Delta which is a low-lying region and very close to the sea (WRI Aqueduct).

Coastal flood risk measures the percentage of the population expected to be affected by coastal flooding in an average year, accounting for existing flood protection standards. Flood risk is assessed using hazard (inundation caused by storm surge), exposure (population in flood zone), and vulnerability. The existing level of flood protection is also incorporated into the risk calculation. It is important to note that this indicator represents flood risk not in terms of maximum possible impact but rather as average annual impact. The impacts from infrequent, extreme flood years are averaged with more common, less newsworthy flood years to produce the “expected annual affected population.” Higher values indicate that a greater proportion of the population is expected to be impacted by coastal floods on average (WRI Aqueduct, 2023).

Asset Risk Score

Climate impacts on the Project are considered based on SSP1-2.6 and SSP5-8.5. Figure 4-10 and Figure 4-11 provide the 'Asset Risk Score' that identifies the potential change in risk profile for the Project. The Project Area is projected to experience a minimal increase in risk because of climate change across both scenarios and for both time horizons (2030 and 2050).

	Asset	Baseline	2030	2050
1	Indorama Train-3	0.44, Minimal Asset Risk	0.68, Minimal Asset Risk	0.74, Minimal Asset Risk

Figure 4-10: Asset Risk Score, SSP1-2.6.

Where:

	Asset	Baseline	2030	2050
1	Indorama Train-3	0.44, Minimal Asset Risk	0.64, Minimal Asset Risk	0.66, Minimal Asset Risk

Figure 4-11: Asset Risk Score, SSP5-8.5.

Where:

Risk Score Composition

In addition to the above, the key climate change hazards deemed applicable to the Project under scenario **SSP1-2.6** are as follows (also refer to hazard distribution in for the 2030 and 2050 time horizons in Figure 4-12 and Figure 4-13 respectively):

- **Extreme Heat:** the biggest change from the baseline to 2030 and 2050 is a visible increase in extreme heat, with a baseline risk score of 0.24 and then an increase in risk by 2.28 for 2030 and 2.46 for 2050.
- **Extreme Cold:** extreme cold decreases quite drastically from the baseline (2.08) risk score to 2030 by -0.68 and for 2050 by -0.96.
- **Wildfires:** at the baseline wildfires are at a risk score of 0.88, it increases for 2030 by 0.24 and for 2050 by 0.08.

- **Water Stress & Drought:** increases quite a bit from the baseline risk score which is at 0.40 to 0.64 in 2030 and increases to 1.36 in 2050.
- **Extreme Rainfall Flooding:** increases by 0.08 for both 2030 and 2050 from the baseline risk score of 0.40.

The key climate change hazards deemed applicable to the Project under scenario **SSP5-8.5** are as follows (also refer to hazard distribution in for the 2030 and 2050 time horizons in Figure 4-14 and Figure 4-15 respectively):

- **Extreme Heat:** the same as in the previous scenario, the biggest change from the baseline to 2030 and 2050 is a significant increase in extreme heat, with a baseline risk score of 0.24 and then an increase in risk to 2.76 for 2030 and 4.44 for 2050.
- **Extreme Cold:** there is a significant decrease in extreme cold from a 2.08 risk score at the baseline to a 1.04 risk score for 2030 and no risk score for 2050.
- **Wildfires:** same as above, wildfires baseline risk score is 0.88, it increases for 2030 by 0.16, while 2050 has no risk score.
- **Water Stress & Drought:** for baseline has a risk score of 0.40 and 2030, it increases by 0.16 for 2030 and by quite a bit by 0.64 in 2050.
- **Extreme Rainfall Flooding:** is the same for baseline and 2030 with risk score of 0.40, it then increases by 0.08 in 2050.

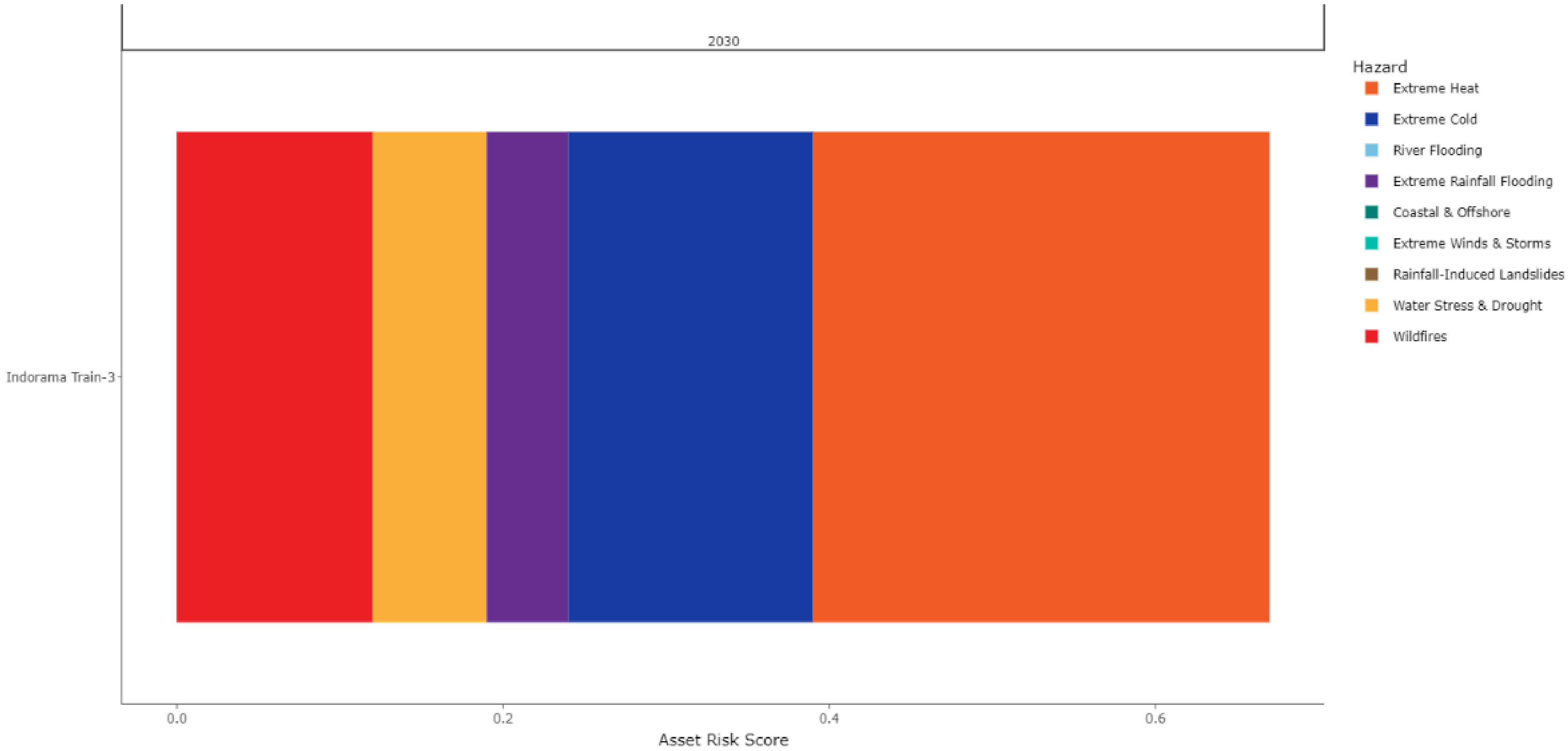


Figure 4-12: Projection Risk Score Composition: SSP SSP1-2.6, 2030.

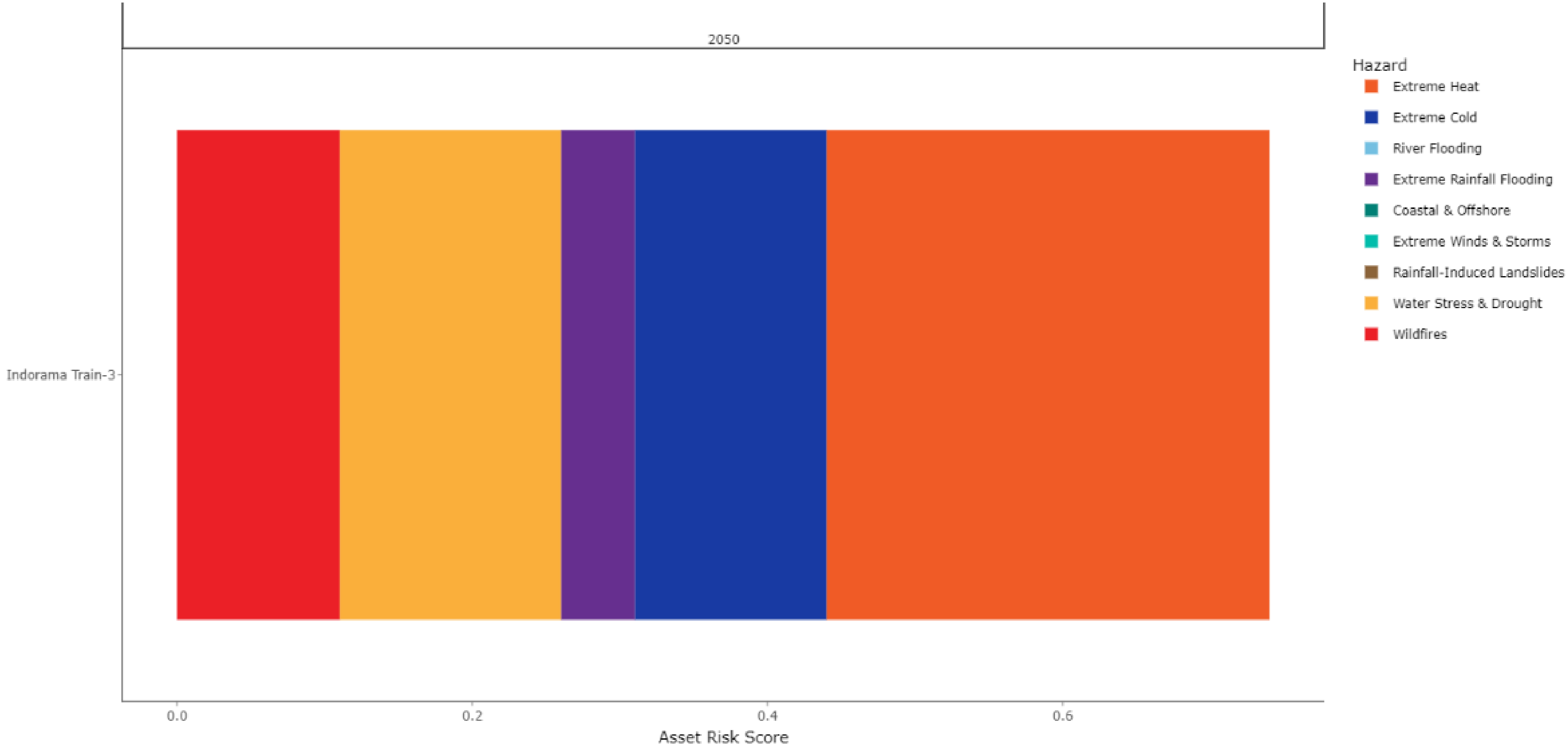


Figure 4-13: Projection Risk Score Composition: SSP SSP1-2.6, 2050.

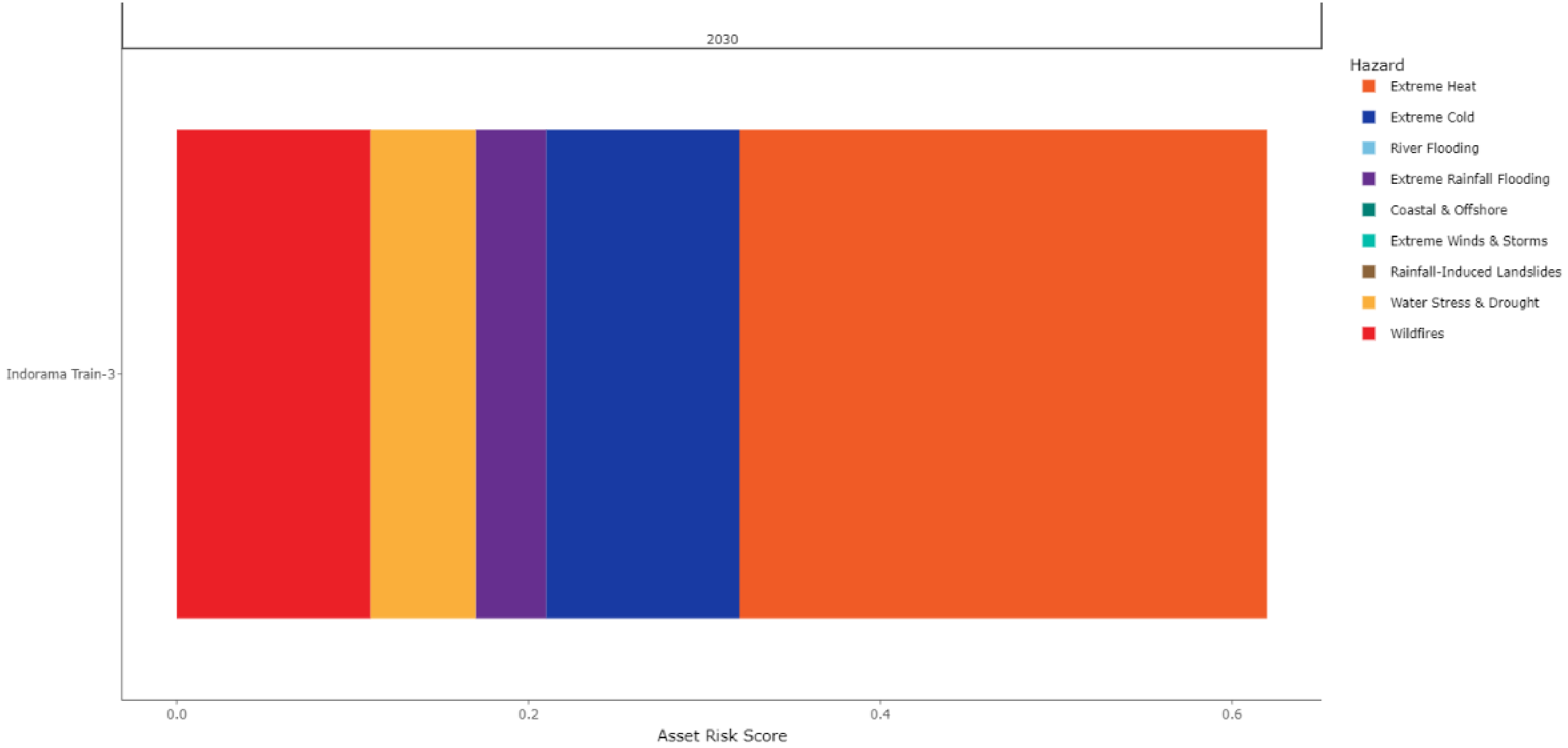


Figure 4-14: Projection Risk Score Composition: SSP SSP5-8.5, 2030.

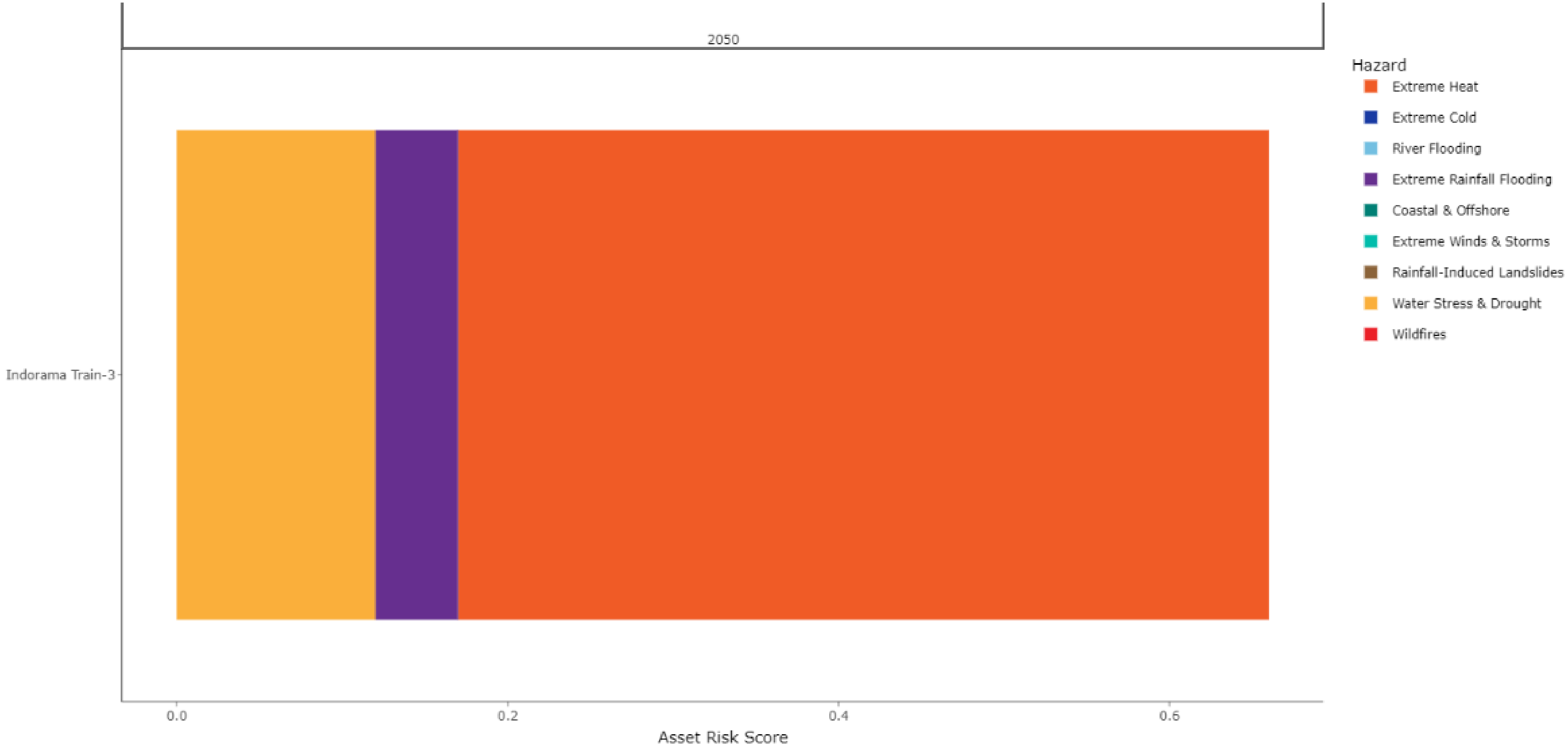


Figure 4-15: Projection Risk Score Composition: SSP SSP5-8.5, 2050.

4.4.2.4 Summary of Key Climate Change Hazards Applicable to the Project

Table 4-2 presents a summary of the potentially material hazards for the Project. Material hazards include:

- Increased extreme heat
- Increased water stress and drought; and
- Increase in both flooding and wildfire events.

Table 4-2: Summary of Prominent Hazards for Baseline and Projections.

Asset: Indorama Train 3	Period									
	Baseline					Projection				
	Prominent Hazards									
SSP1-2.6 & SSP5-8.5										
SSP1-2.6 - 2030							I			I
SSP1-2.6 - 2050							I			
SSP5-8.5 - 2030							I			I
SSP5-8.5 - 2050							I	I		I

Key:

Wildfires	Water Stress and Drought	Extreme Rainfall Flooding	Extreme Cold	Extreme Heat

I – Increase in Hazard for 2030 and 2050.

Note – although wildfires and flooding are not considered a material risk to the Project, these risks have been flagged as a potentially material hazard for the broader Project area. It is important to note that the risk of wildfires is not material in that the actual Project site, as it is situated in an area where year-round relative humidity is in excess of 70% and in an area that has a high annual rainfall. In addition, while portions of the broader Study Area will be susceptible to risks of flooding, the Project area is located at a higher elevation from the Bonny River.

4.4.3 Air Quality

4.4.3.1 Study Area

The Study Area is defined in terms of areas where direct and indirect impacts may occur as a result of the construction, operation or decommissioning of the proposed Project. In terms of air quality, the study considers only direct impacts to sensitive receptors. As such, the Study Area is based on the following distances from the infrastructure design:

- Construction phase:
  - 500m from any construction activities, as this is the maximum distance downwind that dust will travel as a precautionary approach; and
  - 200m from construction access routes.
- Operational phase:

Bulk delivery of granular urea fertilizer, storage, and bulk loading to ships during the operational phase has the potential to impact air quality up to 500m.

4.4.3.2 Baseline Environment

As mentioned in Section 4.4.1, the climate in the Study Area is characterised by two major seasons i.e., dry, and wet seasons, with the wet season from mid-March through to November and a dry season that runs from December through to March. The amount and distribution of rainfall in the Study Area plays an important role in moving pollutants from the atmosphere to other spheres of the environment. The Study Area experiences prevailing wind direction in the south westerly direction, therefore implying that in the event of air emissions from the Project Area, the pollutants in the air will be driven north-east where other industrial port activities exist.

At present, the Project Area has been filled and is devoid of vegetation. Moreover, it lies adjacent to other port operations. As a result, the existing conditions are not a true baseline, but are influenced by the presence of these activities within the Study Area.

Within the Project area the main sources of air pollution are:

- Nearby residential areas that include household heating fires and cooking
- Urban Traffic
- Existing port operation; and
- Road dust from nearby paved and unpaved roads.

4.4.3.3 Summary of the Ambient Monitoring Campaign

Limited ambient monitoring information is currently available. Data from Air Quality study undertaken by ECSL for the Project indicates the following:

- The study of the proposed Project area was conducted from July 4th to July 17th, 2023;
- Hourly mean monitoring was carried out for 14 to 23 hours;

- The baseline will be variable over time at each monitoring location and a single 24-hour sample will be highly unrepresentative of the typical baseline at any one location; and
- The air quality monitoring exercise was conducted using digital gas detector instruments.

The details of the senor are outlined in Table 4-3 below.

Table 4-3: Sensor Details.

Sensor	Sensor type	Range	Minimum detection limit	Accuracy	Resolution
Nitrogen dioxide (NO_2)	GSE (Gas Sensitive Electrochemical)	0-1ppm	0.005ppm	<±0.02ppm 0-0.2ppm <±10% 0.2-1ppm	0.001ppm
Sulphur dioxide (SO_2)	GSE (Gas Sensitive Electrochemical)	0-10ppm	0.04ppm	<±0.05ppm 0-0.5ppm <±10% 0.5-10 ppm	0.01ppm
Ammonia (NH^3)	GSE (Gas Sensitive Electrochemical)	0-25ppm	0.05ppm	<±0.5ppm 0-5ppm <±10% 5-25 ppm	0.01ppm
Particulate Matter ($PM_{2.5}$ & PM_{10})	LPC (Laser Particle Counter)	0.001-1000 mg/m^3	0.001mg/m3	±0.005 mg/m3 +15%	0.001 mg/m^3

As per data from the AQ report the average values for various pollutants for both the wet and dry seasons are outlined in Table 4-4 and Table 4-5, respectively with comprehensive results attached as **Annexure 4.2** and the monitoring locations are illustrated in Figure 4-16. The wet season data was obtained from the air quality monitoring report for MM Port FZE, and dry season data was obtained as secondary data from the study, which was conducted in 2022, hence the location for both seasons vary. The dry season data indicates that study followed spot monitoring procedure where the pollutants were measured for a maximum of 10 minutes.

The summary of results outlined in Table 4-4 and Table 4-5 show the summary values of the pollutants measured in the wet and the dry season respectively. The wet season results indicate that NO_2 has an average of 9.32 µg/m^3, while the dry season data had an average of 24.5 µg/m^3, both results were below the IFC guidelines. The results for NH_3 were well below the project guideline. The average for PM_{10} and $PM_{2.5}$, were below the IFC guidelines, however the average for $PM_{2.5}$ was more than 95% of the project guideline during the dry season.

Table 4-4: Ambient Air Quality Data for the Wet Season.

Parameter	AN1	AN2	AN3	AN4	AN5	AN6	AN7	AN8	AN9	AN10	AN11	AN12	ANC1	ANC2	Max	Ave.	Project Guideline	IFC
NO_2 (µg/m^3)	9.85	9.65	9.84	9.48	9.24	9.91	8.35	9.05	9.02	8.18	9.04	8.74	10.54	9.55	10.54	9.32	40	40
NH_3 (µg/m^3)	1.33	1.45	2.13	1.33	1.23	1.75	1.63	2.07	1.76	1.73	1.92	1.81	2.70	2.33	2.70	1.80	200	-
PM_{10} (µg/m^3)	12.6	15.5	12.5	11.6	12.0	12.2	11.8	12.4	12.6	13.1	12.8	12.4	13.4	12.8	15.5	12.7	60	70
$PM_{2.5}$ (µg/m^3)	7.28	7.12	7.10	6.24	6.76	6.85	6.72	6.18	6.62	6.71	6.45	6.93	7.63	7.34	7.63	6.85	20	35

Table 4-5: Ambient Air Quality Data for the Dry Season.

Station	AQ1	AQ2	AQ3	AQ4	AQ5	AQ6	AQ7	Max	Average	Project Guideline	IFC
NO_2 (µg/m^3)	22.57	24.45	30.1	18.81	22.57	30.1	22.57	30.1	24.5	40	40
NH_3 (µg/m^3)	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	200	-
PM_{10} (µg/m^3)	52.0	48.0	33.0	54.0	47.0	35.0	39.0	54.0	44.0	60	70
$PM_{2.5}$ (µg/m^3)	19.0	21.0	17.0	22.0	16.0	26.0	18.0	26.0	19.9	20	35

Table 4-6: Baseline.

Parameter	Baseline used (µg/m^3)
NO_2 (µg/m^3)	14.4
NH_3 (µg/m^3)	1.20
PM_{10} (µg/m^3)	23.1
$PM_{2.5}$ (µg/m^3)	11.2

The baseline used in the assessment is the average of the wet and dry season measurements obtained at 14 locations. The baseline is understood to be generally representative of the airshed at the port location and at nearby sensitive receptors.

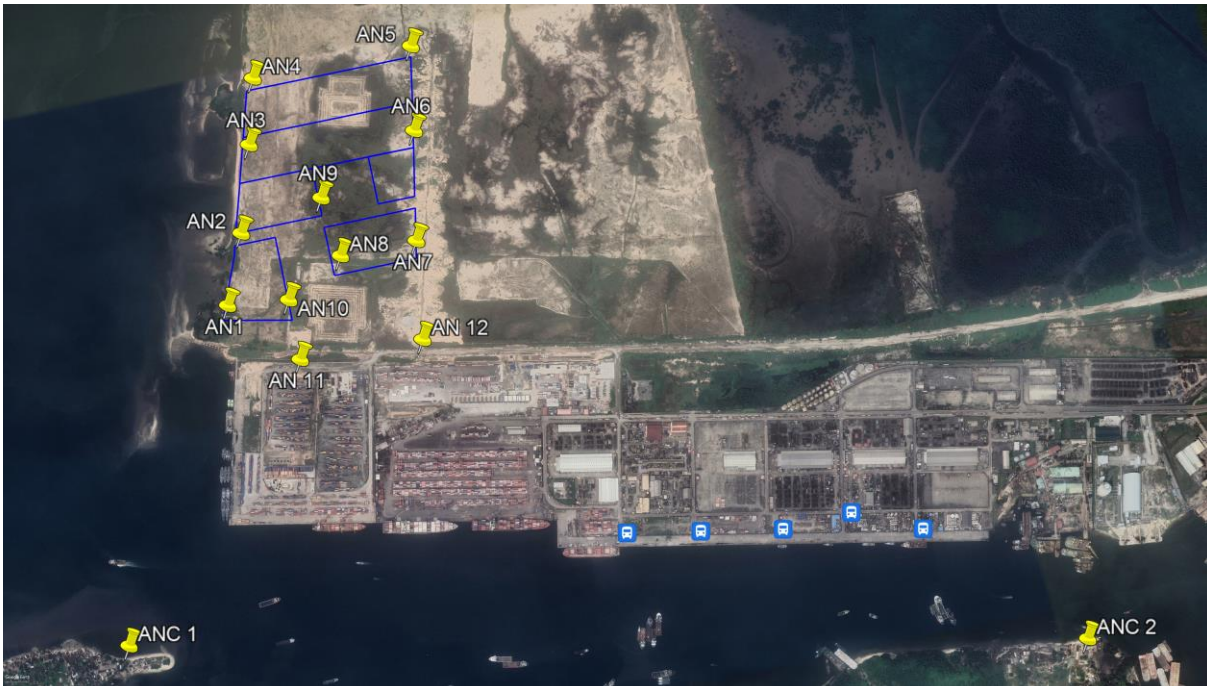


Figure 4-16: Ambient Air Quality Monitoring Stations.

4.4.4 Noise

4.4.4.1 Introduction

An important part of the noise assessment is the quantification and understanding of the existing acoustic environment, including the identification of baseline noise levels at potentially Noise Sensitive Receptors (NSRs). The baseline environment can be defined as the conditions that would prevail in the absence of the proposed Project.

This Section presents the results of the baseline noise survey undertaken by ECSL appointed by MM FZE between the period 4th to 17th July 2023, in compliance with statutory requirements. The quantification of baseline noise levels provides the basis for the assessment of potential noise impacts at NSR's as a result of the Project. Noise measurement locations were chosen to achieve a representative understanding of the noise baseline at NSRs in the vicinity of the Project.

4.4.4.2 Methodology

Sampling Strategy

A noise survey was carried out at 14 sampling stations (shown in Table 4.7a) within the Study Area. The ten (10) out of the fourteen (14) stations were located within the proposed site, two located around project site, while two control stations were located about two (2) to three (3) kms away from the Project site Figure 4-17.

A brief description of the sampling stations relative to the Project site, sampling station codes, and coordinates are presented in Table 4.7a. The first controls station (NC1) was monitored at Owo Ogono community, located approximately 1.8km from the project site; while the second control station (NC2) was monitored at Ele community, located about 2.7km from the Project site.

Table 4.7: Sampling stations and Coordinates.

Station	Description	Latitude	Longitude
N1	Within the project site boundary in South, Southeast directions	4°40'00.60"N	7°8'47.40"E
N2	Within the project site boundary in South, Southwest directions	4°40'02.30"N	7°8'37.88"E
N3	Within the project site boundary in South, Southwest directions	4°40'05.95"N	7°8'28.79"E
N4	Within the project site boundary in West, South directions	4°40'07.01"N	7°8'20.89"E
N5	Within the project site boundary in West, Northwest directions	4°40'22.98"N	7°8'21.48"E
N6	Within the project site boundary in North, Northwest directions	4°40'22.62"N	7°8'30.84"E
N7	Within the project site boundary in North, Northeast, Southeast directions	4°40'19.76"N	7°8'42.39"E
N8	Inside the project site	4°40'10.79"N	7°8'41.83"E
N9	Middle of project site	4°40'09.97"N	7°8'29.96"E
N10	Inside the project site	4°40'07.56"N	7°8'45.88"E
N11	Within the project site boundary in South, Southeast directions	4°40'05.08"N	7°8'51.93"E
N12	Within the project site boundary in East, North, Southeast, directions	4°40'17.68"N	7°8'52.74"E
NC1	Outside the project site boundary in South, Southeast directions (After river) – Owo Ogono community	4°39'33.39"N	7°9'21.92"E
NC2	Outside the project site boundary in Northeast, Southeast directions (After river) – Ele community	4°41'23.76"N	7°9'39.04"E

Source ECSL 2023 Field sampling.

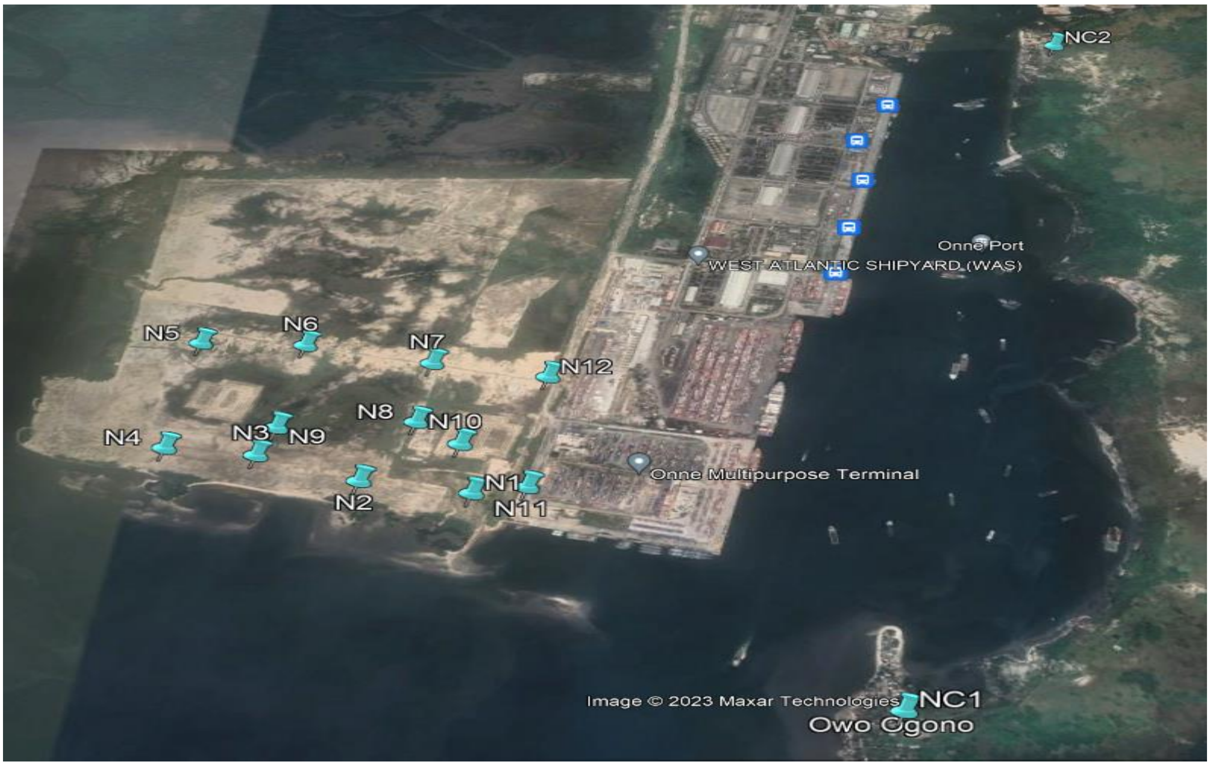


Figure 4-17: Map Showing Ambient Noise Monitoring Stations.

Instrumentation and Sampling Techniques

Noise monitoring was undertaken using the CYGNET Integrating Datalogging Sound Level Meter 2001. This datalogging Sound Level Meter is a Type 1 accuracy (Precision grade) instrument conforming to IS 9779:1981 and Class 1 IEC 61672:2013 with built-in smart integrating algorithms. The equipment has a measuring range of 34-134dB in three scales, each with a dynamic range of 50dB. The scales are 34-84dB, 54-104dB, 84-134dB. It also measures noise with A, C and Lin weightings. A slow, fast, and impulse time response is provided on the equipment, and it can store up to 128K readings in its memory and the time interval between readings may be set between 0.025 seconds and 9999 seconds. It was calibrated with a digital Multi- Range Sound Acoustic Calibrator. The instrument measure noise levels via a microphone probe that generates signals appropriately proportional to sound waves. The sensor of the noise meter was directed up wards and the readings were recorded by instrument in one-minute intervals. The monitoring period was during the day (08:00 to 18:00) and one hour at night (23:00 to 06:00). During the monitoring period there were no rains and, the wind speed was less than 5m/s. The instrument was placed approximately 1.5m above the ground level in open terrain and no closer than 3m to any reflecting surface. The recorded noise data were downloaded and processed by using DL03 software to get the various noise indices.

Table 4-8: Monitoring Station Details.

Station Code	Sampling Location	Monitoring Date	Monitoring duration (min.)		Remark or Field Observation, if any
			Day	Night	
N1	Within the Project Site boundary in South	04/07/23	367	60	Natural sounds, Nigerian Navy Ship base, port activities
N2	Within the Project Site boundary in South	05/07/23	330	60	Natural sounds, Nigerian Navy Ship base, port activities
N3	Within the Project Site boundary in South	06/07/23	367	60	Natural sounds, Nigerian Navy Ship base, port activities
N4	Within the Project Site boundary in West	07/07/23	367	60	Natural sounds, Nigerian Navy Ship base, port activities
N5	Within the Project Site boundary in West	08/07/23	420	60	Natural sounds, earth moving equipment working on the northern side of the Project site
N6	Within the Project Site boundary in North	09/07/23	304	60	Singing birds, earth moving equipment working on the northern side of the project site
N7	Within the Project Site boundary in North	10/07/23	367	60	Natural sounds, earth moving equipment working on the northern side of the Project site
N8	Inside the Project Site	11/07/23	367	60	Natural sounds, Nigerian Navy Ship base, port activities
N9	Middle of Project Site	12/07/23	367	60	Natural sounds, Nigerian Navy Ship base, port activities
N10	Inside the Project Site	13/7/2023	367	60	Natural sounds, Nigerian Navy Ship base, port activities
N11	Within the Project Site boundary in South,	14/7/2023	360	60	Natural sounds, Nigerian Navy Ship base, port activities
N12	Within the Project Site boundary in East,	15/7/2023	429	60	Natural sounds, earth moving equipment working on the northern side of the project site

Station Code	Sampling Location	Monitoring Date	Monitoring duration (min.)		Remark or Field Observation, if any
			Day	Night	
NC1	Outside the Project Site boundary in South, (After river) – Owo Ogono community	16/7/2023	300	60	Natural sounds and sounds from the community
NC2	Outside the Project Site boundary in Northeast, (After river) – Ele community	17/7/2023	300	60	Natural sounds and sounds from the community

(Source ECSL 2023 field sampling)

4.4.4.3 Baseline Noise Results

The results of measurements recorded at during the day and at night at the noise-monitoring locations are summarized in Table 4-8, while the detailed noise results are presented in **Annexure 4.3**

Table 4-9: Noise Monitoring Results

	Daytime (dBA)							Night-Time (dBA)					
Station	Min.	Max.	L_{10}	L_{50}	L_{90}	L_{eq}		Min.	Max.	L_{10}	L_{50}	L_{90}	L_{eq}
N1	41.9	53.9	48.4	47.3	45.8	47.4		35.9	40.3	39.3	38.6	36.8	38.7
N2	42.1	55.1	51.0	48.4	47.5	48.6		35.9	41.6	40.8	39.8	38.5	39.9
N3	41.1	52.6	49.3	48.1	47.1	48.2		41.1	52.6	40.9	38.3	37.5	38.5
N4	42.1	55.3	50.2	48.2	44.6	48.7		36.2	41.9	38.9	38.5	37.2	38.6
N5	42.1	53.7	49.5	47.9	45.6	48.1		36.1	41.8	40.2	38.5	36.9	38.7
N6	41.6	55.1	50.1	48.5	47.4	48.6		36.2	40.8	40.2	38.8	37.4	38.9
N7	41.9	55.4	52.9	48.8	47.9	49.2		36.6	41.9	41.1	39.7	38.1	39.4
N8	42.3	55.2	51.3	49.5	47.8	49.8		36.2	41.9	41.3	39.3	37.4	39.5
N9	41.7	55.6	50.0	49.0	48.1	49.1		36.1	41.9	40.9	39.8	38.7	39.9
N10	41.8	54.7	49.4	47.0	46.8	47.1		36.2	42.6	40.7	38.7	37.1	38.9
N11	41.8	54.5	50.3	48.5	45.6	48.9		36.1	41.8	39.1	38.7	37.2	38.8
N12	41.9	55.1	50.7	47.3	46.8	47.5		35.8	41.7	40.1	38.5	37.5	38.6
NC1	42.1	55.7	52.3	50.8	48.2	51.1		36.1	42.1	40.1	39.3	37.2	39.9
NC2	42.1	52.9	51.3	48.5	45.9	49.0		36.2	41.3	40.8	39.5	37.0	39.7

(Source ECSL 2023 field sampling)

Baseline noise levels around the Project area are generally low and within the prescribed permissible limits. Daytime noise levels (Leq) comply IFC guideline of 55dB at all measured locations. Night-time noise levels (Leq) comply IFC guidelines of 45dB at locations.

4.4.5 Geology

4.4.5.1 Regional geology of the study area

Regionally, the Project Area is situated within the greater Niger Delta. The Niger Delta is one of the significant regressive deltaic sequences in the world. The delta is over 12km thick and occupies an area of 75,000km^2 in the Gulf of Guinea. The Niger Delta basin is underlain by three formations, which include Benin, Agbada and Akata Formations.

The Benin Formation belongs to the Pliocene-Pleistocene age (Owoyemi, August 2004) and. is made up of over 90% massive, porous, coarse sands with clay/shale inter-beds.

The Quaternary deposits (which is 40-150 m thick) generally consist of rapidly alternating sequences of sand and silt/clay with the latter becoming increasingly more prominent seawards. The Niger Delta can be subdivided into three major inter-gradational geomorphologic units from land to sea (north to south), these are:

- Dry deltaic plain with rare freshwater swamps;
- Extensive freshwater swamps and meander belts; and
- Saltwater mangrove swamps, estuaries, creeks, and lagoons.

The dry deltaic plain is a geographically extensive low-lying area dominated by fluvial systems, some with braided characteristics. Few meander belts occur within this deltaic plain. Extensive lateritic soil (approximately 12 m in thickness) underlies this unit. A summary of the geological and lithological unit of the Niger Delta is provided in Table 4-9. A map of the geological characteristics of the Niger Delta is shown in Figure 4-18.

The Niger Delta hydrogeological set up can be classified into (a) Impermeable/Semi permeable horizons from ground level to 10 m below mean sea level. (b) A permeable/gravel sand layer up to 80 meters below sea level. (c) From 80 m to 225 m below sea level (mbsl), the formation consists of a permeable sand/gravel layer with thin impermeable/semi permeable clay/silt layers.

Table 4-10: Geological and lithological units of the Niger Delta.

<table>
<tr><th>Geological Unit</th><th>Lithology</th><th>Age</th></tr>
<tr><td>Alluvium</td><td>Gravel, sand, clay silt</td><td rowspan="5">Quaternary</td></tr>
<tr><td>Freshwater back-swamp</td><td rowspan="2">Sand, clay, some silt, and grave</td></tr>
<tr><td>Meander belt</td></tr>
<tr><td>Mangrove and salt Water/backswamps</td><td>Medium-fine sand, clay and some silt</td></tr>
<tr><td>Active/abandoned beach ridges</td><td>Sand, clay and some silt</td></tr>
<tr><td>Benin Formation (Coastal Plain Sand)</td><td>Coarse to medium sand with Subordinate silt and clay lenses</td><td rowspan="3">Tertiary</td></tr>
<tr><td>Agbada Formation</td><td>Mixture of sand, silt and shale</td></tr>
<tr><td>Akata Formation</td><td>Shale, sandy in some places</td></tr>
</table>

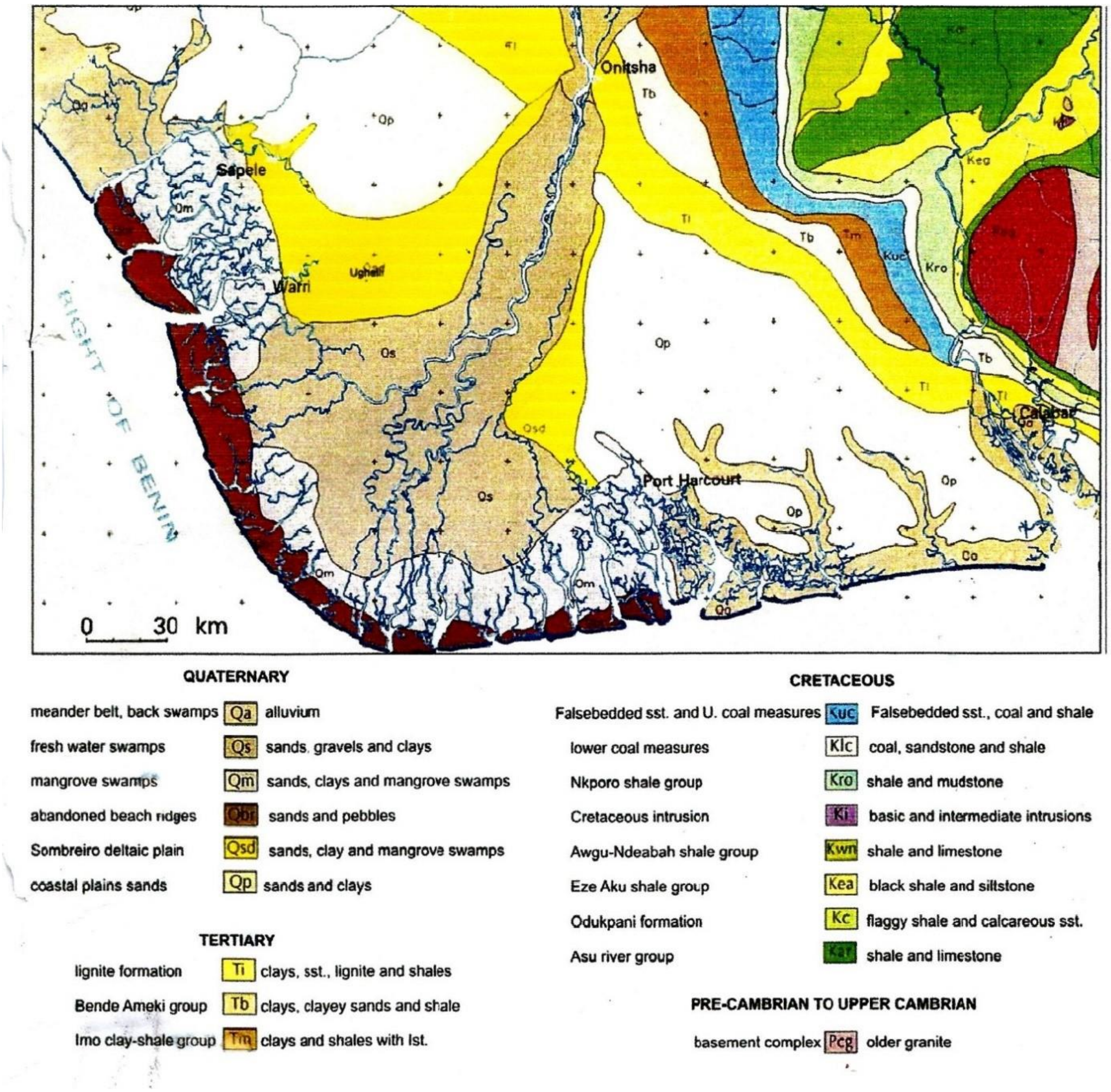


Figure 4-18 Map of the geological characteristics of the Niger Delta (ECSL, 2023)

4.4.5.2 Site Specific Geology

The Project site lies on the bank of the Bonny River (Environmental and Chemical Services Limited, 2023). The geology of the site is composed of coarse-grained sands, medium to coarse grained sands, medium grained sands, medium to fine grained sands, sandy clay, silty clay, clayey sands, and organic clay.

The Project site is a reclaimed sand-filled area. The stratigraphic units in the area comprise of:

- Layer 1: Medium grained sands and medium to coarse grained sandy soils occupying between 4.50m to 7.0m below ground surface. This area is a sand-filled area, and the thickness of the sand-filled area decreases away from the shoreline;

- Layer 2: Underlying layer 1 is a thick layer of silty clay and organic clay which stretches to a depth between 12.0m and 14.0m. The 7.0m thick layer of clayey soils extends throughout the entire area and acts as a barrier that impedes surface infiltration from entering the subsurface environment;
- Layer 3: The thick clay layer is underlain by a continuous layer of sandy clay which extends to a depth ranging from 17.0m to 20.0m; and
- Layer 4: Layer 3 is underlain by medium sands, medium to coarse sands and coarse sands to a depth of 30.0m. This layer varies in thickness from 9.0m to 11.0m.

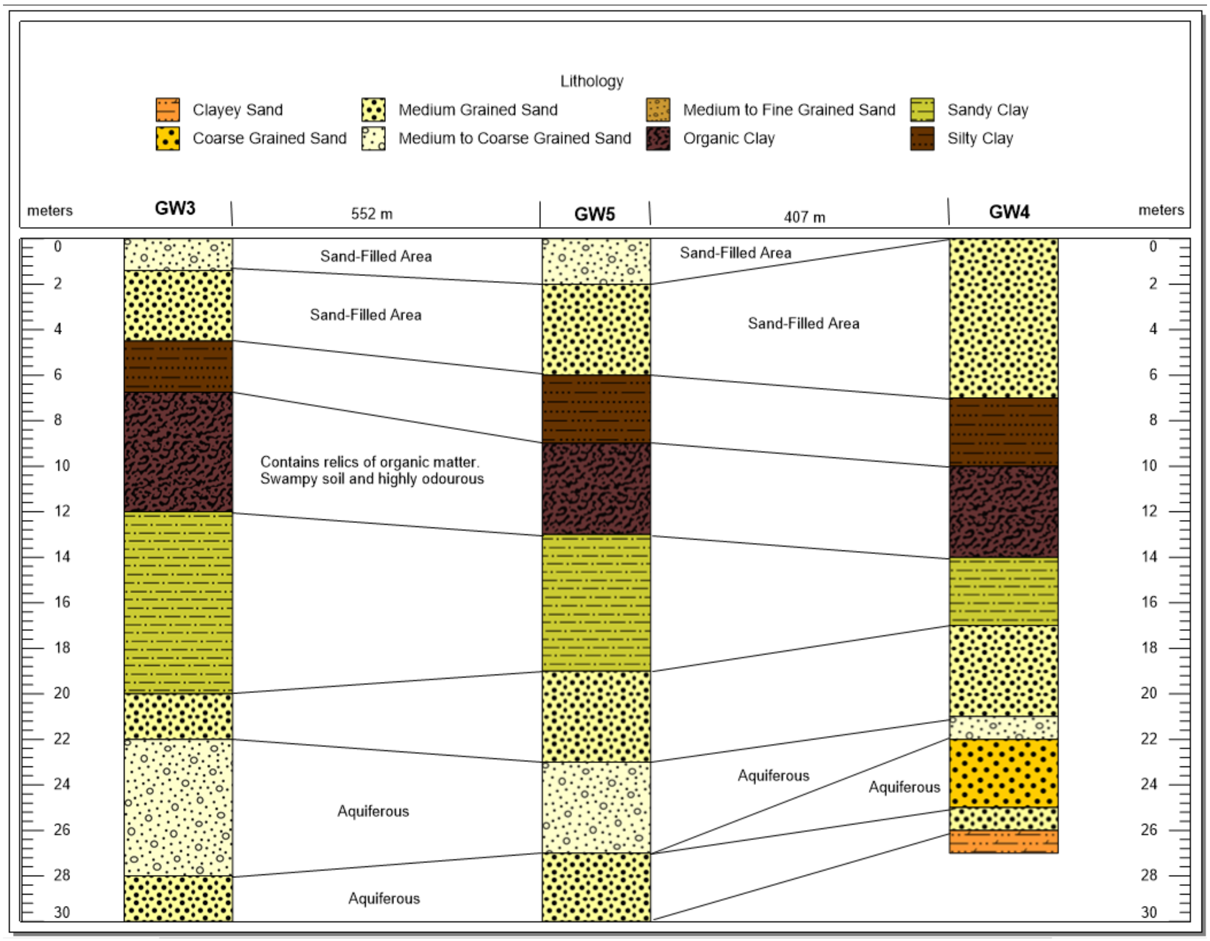


Figure 4-19 Lithostratigraphy of the Project Area

4.4.6 Soils

This *Section* presents the baseline/existing soil conditions in the Project area. The existing soil conditions were assessed through a wet season field sampling campaign undertaken by ECSL in July 2023 and the laboratory analysis carried out by the FMEnv accredited laboratory.

4.4.6.1 Soil Sampling Locations

Soil samples were collected from seven sampling positions situated within the Project Area and one position located outside of the Project Area. At each sampling location, two samples were collected, which included a topsoil sample (0 – 15 cm) and a sub-soil sample (15 – 30 cm). Table 4-10 provides a description of the various soil sampling locations, which are also illustrated in *Figure 4-20*.

Table 4-11: Soil Sampling Locations

S/No	Station Code	Sample Location Description	WGS 84	
			LATITUDE (N)	LONGITUDE (E)
1	SS1	Within Proposed Project Area	4^0 39’ 59.6”	7º 08’ 45.6”
2	SS2	Within Proposed Project Area	4^0 40’ 01.8”	7º 08’ 36.4”
3	SS3	Within Proposed Project Area	4^0 40’ 07.2”	7º 08’ 25.0”
4	SS4	Within Proposed Project Area	4^0 40’ 05.7”	7º 08’ 34.4”
5	SS5	Within Proposed Project Area	4^0 40’ 03.9”	7º 08’ 48.2”
6	SS6	Within Proposed Project Area	4^0 40’ 07.0”	7º 08’ 31.7”
7	SSC1	Control, Outside of the Project Area	4^0 40’ 03.9”	7º 08’ 48.6”

(Source ECSL 2023 field sampling)

Figure 4-20 Soil Sampling Locations

4.4.6.2 Soil Morphology

The soils of the region are classified as coastal plain sand (ultisoil), friable when dry and sticky when wet. However, observation from the field revealed the soil of the proposed Project site is reclaimed with river sand, which dominated soil aggregates as recorded from the particle size distribution analysis, making it friable both at wet and dry within the two depths sampled. The soil colour was generally grey due to river sand used in site reclamation. The site topography is generally flat with a minor slope close to the river shore (Environmental and Chemical Services Limited - c, 2023).

4.4.6.3 Physical Properties

The results from the physical and chemical analyses are summarised in Table 4-11, while the comprehensive soil results for sampled location is presented in **Annexure 4.4**. The porosity values for the topsoil on site range from 37.30 to 41.00 and 36.80 to 40.20 for subsoil, indicating varying levels of pore space within the soil samples, thus indicating soil capability to encourage good soil aeration. The same range of porosity was observed at the control station.

The permeability of the soil on site ranges from 0.13 to 0.17cm/sec x10^3 for topsoil and 0.10 to 0.16cm/sec x10^3 for subsoil suggesting moderate permeability in the soil samples and soil's ability to transmit water. Similar permeability results were observed at the control stations indicating no soil compaction at project site.

The soil texture within and around the proposed Project site is sandy soil. This is based on the high percentage of sand (83.28 -86.54% and 82.64-86.72% for topsoil and subsoil respectively), as observed from the particle size distribution and physical observation in the field (Environmental and Chemical Services Limited - c, 2023).

4.4.6.4 Chemical Properties

The pH values as measured from a total of fourteen soil samples collected on site range between 6.00 to 7.40 and 5.80 to 7.50 for subsoil indicating a slightly acidic to alkaline soil. Results from the heavy metals analyses showed heavy metal concentrations which are typical of the Niger Delta soil environment, indicating no form of pollution. Hydrocarbon analysis showed low concentrations with Total Hydrocarbon Content (THC) concentrations of between 0.75-2.46mg/kg and 0.65-1.75mg/kg for topsoil and subsoil respectively, indicating that the hydrocarbon source is biogenic.

Comparison of the current laboratory results with previous study within the study area showed no significant variation in soil quality (Environmental and Chemical Services Limited - c, 2023).

Table 4-12: Summary Results of Soil Physiochemical Properties Within and Around the Proposed Project Site

S/N	Parameter(s)	MM FZE PORT 2023 (Wet)			
		Min	Max	Ave	SSC
		Topsoil 0-15cm)			
1	Sand (%)	83.28	86.54	84.93	85.10
2	Silt (%)	5.39	8.28	6.67	6.50
3	Clay (%)	7.46	9.46	8.40	8.40
4	Texture	0.00	0.00	~	SS
5	Porosity	37.30	41.00	39.18	37.60
6	Colour	~	~	~	Dark Brown
7	Permeability (cm/sec)×10	0.13	0.17	0.15	0.15
8	Bulk Density (g/cm3)	1.16	1.42	1.33	1.56
9	pH	6.00	7.40	6.58	6.50
10	Moisture Content (%)	7.55	12.45	9.69	7.64
11	Sulphide, S2 (mg/kg)	<0.01	<0.01	<0.01	<0.01

S/N	Parameter(s)	MM FZE PORT 2023 (Wet)			
		Min	Max	Ave	SSC
12	Sulphate, SO42- (mg/kg)	4.00	12.00	6.17	11.00
14	Nitrate, NO3- (mg/kg)	1.50	2.30	1.98	3.40
15	Total Nitrogen (%)	0.015	0.034	0.03	0.024
16	Phosphate, PO43- (mg/kg)	0.65	2.50	1.40	1.81
18	TOC (%)	0.27	0.59	0.36	0.27
19	THC (mg/kg)	0.75	2.45	1.73	2.46
21	Ammonia (mg/kg)	<0.01	<0.01	<0.01	<0.01
22	Urea (Urea)	<0.01	<0.01	<0.01	<0.01
23	Manganese, Mn (mg/kg)	1.66	12.18	4.93	32.57
24	Iron, Fe (mg/kg)	695.3	1613.8	1070.21	3,068.8
25	Zinc, Zn (mg/kg)	2.60	7.71	3.92	17.06
26	Vanadium, V (mg/kg)	<0.001	<0.001	<0.001	<0.001
27	Nickel, Ni (mg/kg)	0.08	0.41	0.25	<0.001
28	Chromium, Cr (mg/kg)	<0.001	<0.001	<0.001	<0.001
29	Lead, Pb (mg/kg)	<0.001	<0.001	<0.001	<0.001
30	Copper, Cu (mg/kg)	<0.001	<0.001	<0.001	0.61
31	Mercury, Hg (mg/kg)	<0.001	<0.001	<0.001	<0.001
32	Arsenic, As (mg/kg)	<0.001	<0.001	<0.001	<0.001
33	HUB (CFU/g) x 10^3	0.30	0.80	0.57	0.60
34	HUF (CFU/g) x 10^3	0.20	0.50	0.33	0.30
35	THB (CFU/g) x 10^5	1.10	2.80	2.10	3.50
36	THF (CFU/g) x 10^5	0.30	1.10	0.67	1.20
Subsoil (15-30cm)					
1	Sand (%)	82.64	86.72	84.62	84.38
2	Silt (%)	5.14	9.09	7.11	9.31
3	Clay (%)	7.42	8.75	8.27	9.31
4	Texture	0.00	0.00	~	SS
5	Porosity	36.80	40.20	38.83	37.00
6	Colour	~	~	~	Dark Brown
7	Permeability (cm/sec)×10	0.10	0.16	0.14	0.14
8	Bulk Density (g/cm3)	1.25	1.58	1.38	1.45
9	pH	5.80	7.50	6.67	6.60
10	Moisture Content (%)	8.12	12.31	10.39	8.50
11	Sulphide, S2 (mg/kg)	<0.01	<0.01	<0.01	<0.01
12	Sulphate, SO42- (mg/kg)	2.00	16.00	7.67	10.00
14	Nitrate, NO3- (mg/kg)	1.40	2.80	2.00	1.90
15	Total Nitrogen (%)	0.016	0.041	0.03	0.014
16	Phosphate, PO43- (mg/kg)	0.75	1.85	1.37	1.65
18	TOC (%)	0.19	0.47	0.29	0.17
19	THC (mg/kg)	0.65	1.75	1.24	1.40
21	Ammonia (mg/kg)	<0.01	<0.01	<0.01	<0.01
22	Urea (Urea)	<0.01	<0.01	<0.01	<0.01
23	Manganese, Mn (mg/kg)	2.03	5.77	3.48	17.38
24	Iron, Fe (mg/kg)	358.1	2109.2	988.10	2,713.0

S/N	Parameter(s)	MM FZE PORT 2023 (Wet)			
		Min	Max	Ave	SSC
25	Zinc, Zn (mg/kg)	1.97	3.05	2.60	8.32
26	Vanadium, V (mg/kg)	<0.001	<0.001	<0.001	<0.001
27	Nickel, Ni (mg/kg)	<0.001	<0.001	<0.001	0.46
28	Chromium, Cr (mg/kg)	<0.001	<0.001	<0.001	<0.001
29	Lead, Pb (mg/kg)	<0.001	<0.001	<0.001	<0.001
30	Copper, Cu (mg/kg)	0.14	0.14	0.02	0.19
31	Mercury, Hg (mg/kg)	<0.001	<0.001	<0.001	<0.001
32	Arsenic, As (mg/kg)	<0.001	<0.001	<0.001	<0.001
33	HUB (CFU/g) x 10^3	0.10	0.40	0.20	0.30
34	HUF (CFU/g) x 10^3	0.10	0.20	0.17	0.10
35	THB (CFU/g) x 10^5	0.70	1.90	1.37	2.00
36	THF (CFU/g) x 10^5	0.20	0.60	0.43	0.80

(Source ECSL 2023 field sampling)

4.4.7 Sediments

Sediments at the Bonny River were sampled for analysis. A total of twelve samples were collected by ECSL, of which ten were collected within the zone of influence of the Project, and two as control samples. The samples were submitted for analysis for physical and chemical analysis, as well as for toxicity characteristic leaching procedure (TCLP) testing.

4.4.7.1 Physical and chemical characteristics

The results from the physical and chemical analyses are summarised in Table 4-12, while the comprehensive sediment results are presented in **Annexure 4.5**. The pH concentration ranges between 6.40 – 7.30 with a pH average of 6.94 within the Project area of influence while pH values of 6.40 and 6.90 were recorded at the two control stations indicating that sediment with the project area is slight acidic to alkaline. Ammonia ranges between 0,70 – 0.96mg/kg within the Project influence zone. Total Nitrogen ranged between 0.108 – 0.210%. THC ranged between 7.81 – 15.10mg/kg with 10.73mg/kg average within the Project influence zone. Heavy metals were generally below detection limit except for Iron (Fe), Zinc (Zn) and Cobalt (Co), with iron recording the highest concentration of average of 3,605mg/kg. Zinc concentration measured 13.03mg/kg and cobalt 2.76mg/kg (Environmental and Chemical Services Limited - d, 2023).

Microbial count revealed THB has the highest microbial count with an average of 2.22cfu/g x 10^6, followed by THF with an average count of 1.06cfu/g x 10^6. HUB has an average count of 0.62cfu/g x 10^3 within the Project influence zone, and HUF 0.46cfu/gx10^3 (Environmental and Chemical Services Limited - d, 2023).

Table 4-13: Sediment Physical and Chemical Characteristics (from ECSL, 2023).

Parameter(s)	Min	Max	Ave
Sand (%)	78.25	81.99	80.18
Silt (%)	4.45	6.33	5.34
Clay (%)	12.65	17.25	14.47
Texture	~	~	~
Porosity	0.37	0.40	0.38
Colour	~	~	~
Permeability (cm/sec)×10	0.17	0.2	0.18
Bulk Density (g/cm^3)	1.27	1.53	1.39
pH	6.40	7.30	6.94
Phosphate, PO_4^{3-} (mg/kg)	1.10	1.93	1.47
Sulphide, S_2 (mg/kg)	<0.01	<0.01	<0.01
Sulphate, SO_4^{2-} (mg/kg)	490	710	62
Nitrate, NO^{3-} (mg/kg)	2.4	3.4	2.9
TOC (%)	1.25	2.43	1.62
THC (mg/kg)	7.81	15.10	10.73
Ammonia (mg/kg)	0.70	0.96	0.84
Total Nitrogen (%)	0.108	0.210	0.140
Cobalt, Co (mg/kg)	1.39	4.14	2.76
Manganese, Mn (mg/kg)	25.39	122.5	64.57
Iron, Fe (mg/kg)	2617.7	4333.	3605.0
Zinc, Zn (mg/kg)	11.32	15.74	13.03
Silver, Ag (mg/kg)	<0.001	<0.001	<0.001
Vanadium, V (mg/kg)	<0.001	0.29	0.16
Nickel, Ni (mg/kg)	<0.001	6.13	0.29
Chromium, Cr (mg/kg)	<0.001	<0.001	<0.001
Lead, Pb (mg/kg)	3.05	3.05	3.05
Copper, Cu (mg/kg)	<0.001	0.98	0.08
Mercury, Hg (mg/kg)	<0.001	<0.001	<0.001
Arsenic, As (mg/kg)	<0.001	<0.001	<0.001
THB (CFU/g) x 10^6	1.2	3.2	2.22
THF (CFU/g) x 10^6	0.5	1.7	1.06
HUB (CFU/g) x 10^3	0.3	1.3	0.62
HUF (CFU/g) x 10^3	0.2	1.0	0.46

4.4.7.2 Leach Characteristics

The sediment source is mainly exposed soil and waste material including sewage within and around the Study Area.

Results from the TCLP testing are summarised in Table 4-13. Leachate test for sampled sediments showed parameters tested for leachability generally had low concentrations, and are in compliance with both the EGASPIN 2018 TCLP standard limits, and the Marine Sediment Quality Standards - Chemical Criteria as published in the Sediment Management Standards by Department of Ecology State of Washington, Chapter 173-204 WAC (Environmental and Chemical Services Limited - d, 2023).

Table 4-14: Sediment TCLP Analysis Results (from ECSL, 2023).

Parameter	Min	Max	Ave	TCLP Limit	Marine sediment quality standards
Iron, Fe (mg/l)	2.107	8.145	5.8111	NS	NS
Manganese, Mn (mg/l)	0.258	1.434	0.7337	NS	NS
Zinc, Zn (mg/l)	0.816	2.651	1.7566	50	410
Vanadium, V (mg/l)	<0.001	<0.001	<0.001	NS	NS
Nickel, Ni (mg/l)	<0.001	0.246	0.0246	NS	NS
Chromium, Cr (mg/l)	<0.001	<0.001	<0.001	5	260
Lead, Pb (mg/l)	<0.001	<0.001	<0.001	5	450
Copper, Cu (mg/l)	<0.001	0.076	0.0076	NS	390
Mercury, Hg (mg/l)	<0.001	<0.001	<0.001	0.2	0.41
Arsenic, As (mg/l)	<0.001	<0.001	<0.001	NS	57
Cobalt, Co (mg/l)	<0.001	<0.001	<0.001	NS	NS

4.4.8 Land Use

The proposed Project Site is located within the existing Onne Port complex in Eleme Local Government Area currently managed by Nigerian Ports Authority (Environmental and Chemical Services Limited - c, 2023). The Onne Port complex land was acquired by the Nigerian Government several years back in order to foster industrialisation and also to enable international trade via water ways. Currently, the port complex plays host to over two hundred companies and designated as industrial zone. The closest communities within the Port complex are the Onne and Ogu Community. Remote sensing indicates that the Owo Ogono, is in proximity to the Project site The Ogu community is located to the northeast across the river. The Onne Community is largely a residential area and is 90% built up, while the Ogu communities are fishing settlements with the majority of the buildings being temporary structures.

A Regional Land Use Study covering the greater Eleme Local Government Area (LGA) was performed. Table 4-14 presents the land changes within the Eleme LGA based on a survey carried out between 2006 and 2019. As the population has grown over the period 2006 – 2019, the largest change in land use has been the built-up area, increasing from approximately 19km^2 in 2006 to 49km^2 in 2019. Figure 4-21 shows how the built-up area has expanded between 1986 and 2015. The increase in built-up land area has resulted in a decrease in land area covered by vegetation from approximately 93km^2 in 2006 to 60km^2 in 2019 (combined light and thick vegetation area).

Table 4-15: Population Growth and Land Use Change (2006- 2019)

Year	Population Growth	Built-up Area (km^2)	Farmland (km^2)	Light Vegetation (km^2)	Thick Vegetation (km^2)	Water Body (km^2)
2006	6,273	18.67	24.3	76.79	16.09	2.25
2007	6,467	20.805	24.653	75.213	15.146	2.105
2008	6,686	23.12	25.006	73.636	14.202	1.96

Year	Population Growth	Built-up Area (km^2)	Farmland (km^2)	Light Vegetation (km^2)	Thick Vegetation (km^2)	Water Body (km^2)
2009	6,914	25.435	25.359	72.059	13.258	1.815
2010	7,149	27.75	25.712	70.482	12.314	1.67
2011	7,392	30.065	26.065	68.905	11.37	1.525
2012	7,643	32.38	26.418	67.328	10.426	1.38
2013	7,903	34.695	26.771	65.751	9.482	1.235
2014	8,172	37.01	27.124	64.174	8.538	1.09
2015	8,450	39.325	27.48	62.59	7.594	0.945
2016	8,737	41.64	27.83	61.013	6.65	0.8
2017	9,034	43.955	28.183	59.436	5.706	0.655
2018	9,341	46.27	28.536	57.859	4.762	0.51
2019	9,659	48.585	28.889	56.282	3.818	0.365

Source: Obende et al. 2020

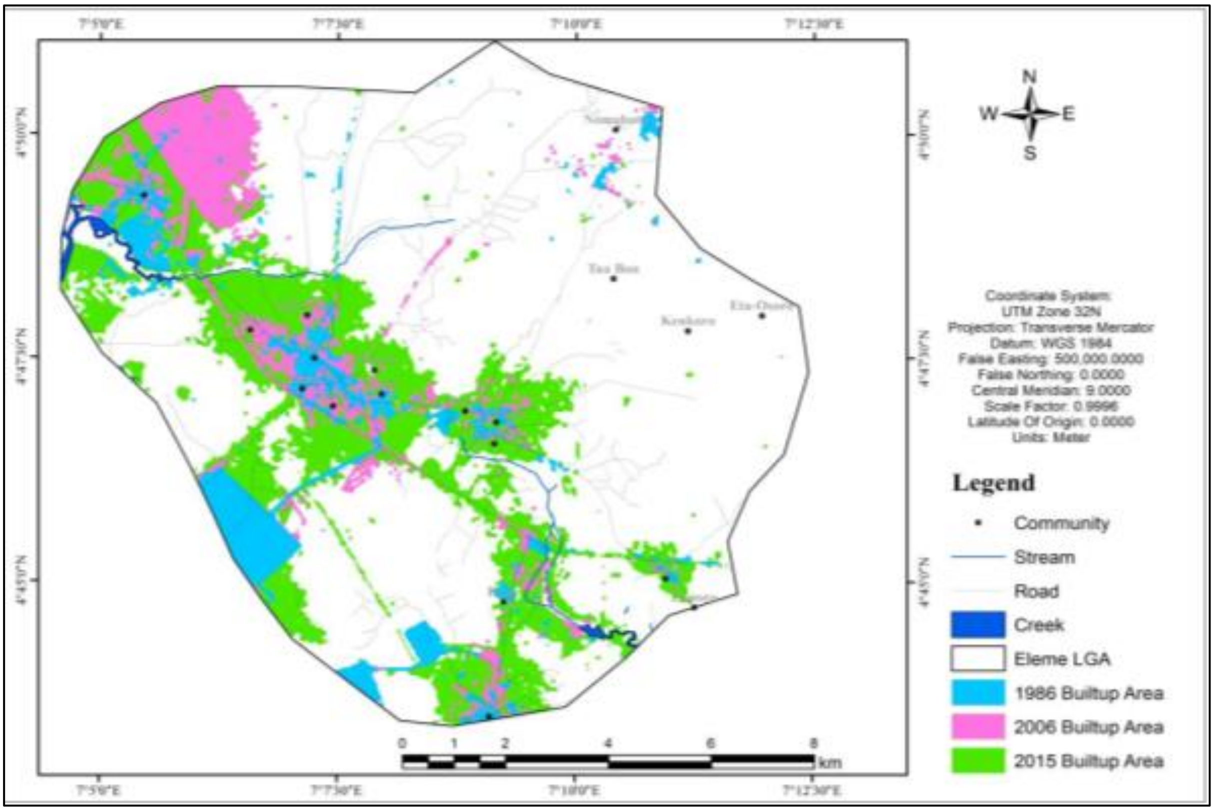


Figure 4-21: Distribution of the Built-up area Within the Eleme LGA (1986-2015) (*Source: Obende et al. 2020)*

A breakdown of the primary land uses in the Eleme LGA is presented in Table 4-15. It is evident from the field observations made that in 2019, residential made up the largest percentage (50%) of the land use, followed by industry covering approximately 35% of the area (Environmental and Chemical Services Limited - c, 2023).

Table 4-16: Observed land use pattern within the Eleme LGA (from ECSL-c, 2023).

Land use	Percentage
Residential	50%
Industry	35%
Agriculture	10%
Undistributed forest	5%
Habitat protected area	0%

4.4.9 Groundwater

This section details the baseline groundwater conditions in the broader Project area. Aspects that are addressed include:

- Aquifers present on site, their depths, thicknesses and interconnection (refer to Section 4.4.10.1);
- Aquifer parameters such as transmissivity and storativity (refer to Section 4.4.9.2);
- Depth to groundwater level and flow patterns (refer to Section 4.4.9.3);
- Groundwater availability (refer to Section 4.4.9.4);
- Groundwater use in the region (refer to Section 4.4.9.5);
- Groundwater quality (refer to Section 4.4.9.6); and
- Groundwater vulnerability (refer to Section 0).

4.4.9.1 Aquifers Present on Site

The main hydrogeological lithologies present in the Study Area are 1.) the Benin Formation which, together with the Akata and Agbada Formations, underlie the Niger Delta (Amajor, 1991), and 2.) the Deltaic Formation (Hassan, 7 November 2019).

The Deltaic Plains (upper and lower) consist of coarse-to-medium-grained unconsolidated sands. These sands form lenticular beds with intercalations of peaty matter and lenses of soft, silty clay and shales (Akpokodje, 1996). The sands are very fine to coarse grained, subangular to subrounded, poor to fairly well sorted and mostly lithic arenites (Amajor, 1991). Gravelly beds, up to 10 m thick, have been reported here. The Benin Formation consists of four well defined aquifers in the upper 300m (Akpokodje, 1996).

Site specific aquifer conditions were obtained from the drilling logs of three groundwater boreholes that were drilled on site. A cross section of the lithologies on site, as derived by Environmental and Chemical Services Limited (ECSL) in their geology / hydrogeology report is shown in Figure 4-22. The lithologies and aquifers are discussed in more detail below.

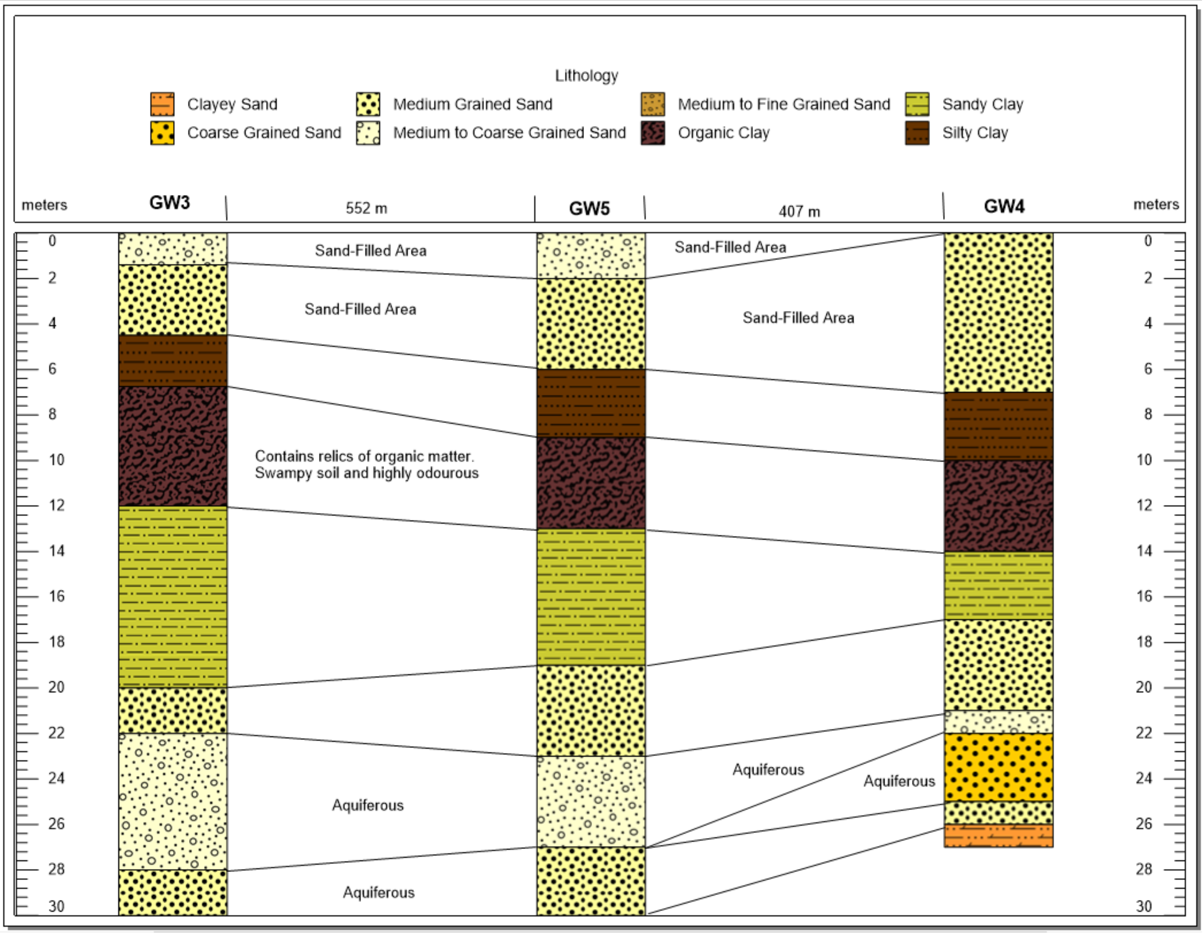


Figure 4-22: Cross section of the lithologies underlying the site (from ECSL, 2023).

Unconfined Aquifers

The deltaic aquifer is classified as unconfined, which is the first and topmost groundwater unit recharged directly by infiltration from precipitation and baseflow. The water table in the Niger Delta area is very close to the ground surface, ranging from 0 to 9m below ground level. This area experiences limited water table fluctuation due to heavy rainfall which varies from about 2,400mm a year inland to 4,800 mm near the coast although some proportion of the rainfall is lost through runoff and evapotranspiration.

The proposed Project area is a reclaimed sand filled area which decreases in thickness with increasing distance from the shoreline. The stratigraphic unit underlying the Project site comprises of medium grained sands and medium to coarse grained sandy soils occupying between 4.50m to 7.0m below ground surface. The sandy nature of the layer makes it permeable for surface water and potential contaminants to be transported into the aquifers. Underlying this layer is a thick layer of silty clay and organic clay which stretches to a depth between 12.0m and 14.0m. The 7.0 m thick layer of clayey soils extends throughout the entire area and acts as a barrier that impedes surface infiltration from entering the underlying aquifers (Environmental and Chemical Services Limited, 2023).

Confined Aquifers

These aquifers occur across the Deltaic Formation and the Benin Formation. Moderately high-yielding artesian flows characterise these formations. In some areas, the aquifers are confined by a clay bed up to 36m thick (Adelana, et al.). The depth of the aquifers below this bed is approximately 100m.

Hydrogeological information indicates a hydrological connection between the confined aquifers along the coastline and the unconfined aquifers of the Benin Formation to the north. The aquifers increase in thickness towards the continent, while the confining clays thin out. In the area underlain by the Benin Formation, the confined aquifers occur in the southeastern part of the Niger Delta. Several clay beds confine the aquifers. The confined aquifers consist mainly of very-coarse-to-medium-grained sands.

As mentioned above in the description of the unconfined aquifer, on site a thick layer of silty clay and organic clay underlies the unconfined aquifer at depth of approximately 7 to 14m below surface. This thick clay layer is in turn underlain by a continuous layer of sandy clay to a depth of 20m below surface. These two clay / clayey layers confine the 10m thick, medium to coarse grained, sand aquifer that lies underneath it.

4.4.9.2 Aquifer Parameters

Aquifer hydraulic conductivity / transmissivity, and storage capacity information was obtained from the literature review and site-specific testing that was done on three groundwater boreholes that were drilled on site refer to **Annexure 4.6.**

Unconfined Aquifers

From literature, it is seen that the transmissivity values for the aquifers range from 1.05×10^{-2} to $11.3 \times 10^{-2} m^2/sec$, while the coefficient of storage varies between 1.07×10^{-4} and 3.53×10^{-4}.

The Benin Formation is more permeable than the Deltaic Plains due to the nature of the sediments with a specific capacity ranging between 150 and $1400m^3/d/m$ (Offodile, 1992). The Deltaic Plains have specific capacities ranging from 160 to $320m^3/d/m$ (Offodile, 1992).

Results from the aquifer testing that was done by ECSL on 3 groundwater boreholes that were drilled on site show that the average hydraulic conductivity across the site ranges from 4.96×10^{-5} to $6.49 \times 10^{-5} m/s$. This result suggests groundwater movement ranges between 4.42m/day to 5.60m/day (Environmental and Chemical Services Limited, 2023).

Table 4-17: Aquifer Hydraulic Conductivity (from ECSL).

Borehole	Hydraulic conductivity	
	(m/sec)	m/day
GW3	5.12×10^{-5}	4.424
GW4	6.49×10^{-5}	5.607
GW5	4.96×10^{-5}	4.285

Confined Aquifers

The transmissivity of the confined aquifers is unknown. It should be noted that at the Site, this aquifer is expected to be overlain by the thick unconfined aquifers and are not accessed by water supply boreholes. The specific capacity for the Deltaic Formation varies from 90 to 320m^3/d/m. The specific capacity of the Benin Formation varies between 140 and 180m^3/d/m.

4.4.9.3 Depth to Groundwater Level and Groundwater Flow Patterns

Regional depth to groundwater level data was obtained from literature, while site specific information on the depth to groundwater level was recorded in three groundwater boreholes drilled on site.

Regionally, the depth to the water table ranges between 3 and 15m below ground level (mbgl). A few values for seasonal fluctuations obtained from the area indicated seasonal differences in static water level fall between 2.1 and 3.6m (Hassan, 7 November 2019).

The depth to groundwater level was measured in three groundwater boreholes that were drilled on site (Environmental and Chemical Services Limited, 2023). The measured depth to groundwater level ranged between 3.12 and 4.14m. Results from the drilling of the three groundwater boreholes show that an unconfined aquifer underlies the site. The unconfined aquifer extends to around 7 m below surface, where a 7m thick clay layer underlies the aquifer, and separates it from a 10m thick, deeper, confined aquifer, which is located at between 20 and 30m below surface.

Based on the range of the groundwater levels (3.12 to 4.14mbgl), it appears that the groundwater levels measured on site is representative of the shallow, unconfined aquifer which extends to approximately 7 m below surface. However, it should be noted that all three boreholes were installed to 30 m depth, and also intercepted the deeper confined aquifer. MM FZE have indicated that all aquifers within the Project Area are unconfined to a 30m depth. Slotted casing (screen) was placed at a depth between 25 m – 30 m below ground level. The total screened interval was 5 m. The aquifers identified are unconfined and hence no associated impact or contribution from any surrounding confined aquifers invesaged.

Groundwater flow patterns are interpreted by ECSL (Environmental and Chemical Services Limited, 2023). Hydraulic head ranged from 1.20m above mean sea level (mamsl) to 3.40 mamsl. Hydraulic head is higher towards the northwest and lowest towards the southern part of the study area (towards the Bonny River). Groundwater flows from the northwestern part of the area towards the southeastern and southern part of the project site. Although the localised groundwater flow direction trends towards the Bonny River, over-exploitation of boreholes within the area can cause a reversal in groundwater movement within the area.

Table 4-18: Ground Elevation, Static Water Level and Reduced Groundwater Elevation for the Project Area

ID	UTM Easting (m)	UTM Northing (m)	Ground Elevation (m)	Static Water Level (m)	Reduced Groundwater Elevation (m)
GW3	293715.00	516755.00	6.50	3.12	3.38
GW4	294046.00	516188.00	4.50	3.42	1.08
GW5	294242.00	516545.00	6.50	4.14	2.36

Figure 4-23: Ground Surface Elevation around the Project Area

4.4.9.4 Groundwater Availability

Groundwater is readily available from the underlying aquifers. The aquifer potential is rated as high based on the physical characteristics (medium to coarse grained unconsolidated sands) and the relatively high aquifer transmissivity calculated from hydraulic testing done on site specific boreholes (GW2, GW4, and GW5).

4.4.9.5 Groundwater Use in the Region

The Niger Delta in Nigeria is the economic hub of the country due to crude oil exploration around the basin. This has attracted many petroleum and petrochemical industries into the area resulting in rural-urban migration and a surge in the urban population. Increased population has placed pressure on the available water resources in the area. Data from the National Bureau of Statistics shows that water in the majority of Niger Delta states comes from unsafe supply facilities, such as rivers, lakes, unprotected hand-dug wells and boreholes. Potable water for household consumption used to run in public taps but fell into disrepair 20 years ago, hence people now rely on boreholes, protected wells, unprotected wells, rivers/lakes/ponds, vendor trucks and other water sources. These problems are acute and result in supplies of unsafe water in more than 50% of the cases. These factors have led to a dependence on groundwater from shallow aquifers to meet daily water demands (Hassan, 7 November 2019).

4.4.9.6 Groundwater Quality

Site specific groundwater quality information was obtained from the ECSL groundwater quality assessment (Environmental and Chemical Services Limited - b, 2023). A total of five groundwater samples, and one control sample, were collected by ECSL. Details of the sampling positions are summarised in Table 4-18, while groundwater chemistry for wet and dry season is presented in table 19a and 19b for wet and dry season respectively. The sampling map is shown in Figure 4-24.

Boreholes GW1 and GW2 are existing boreholes, GW3 to GW5 are three newly drilled boreholes. The control point (GWC1) is a borehole which is located in the neighbouring community.

Table 4-19: Groundwater Sampling Positions (ECSL, 2023).

Sampling point	North	East
GW1	4°40'12.24"N	7° 8'55.48"E
GW2	4°40'52.65"N	7° 9'11.81"E
GW3	4°40'20.97"N	7° 8'25.68"E
GW4	4°40'03.15"N	7° 8'36.06"E
GW5	4°40'14.84"N	7° 8'42.40"E
GWC1	4°39'41.01"N	7° 9'21.21"E

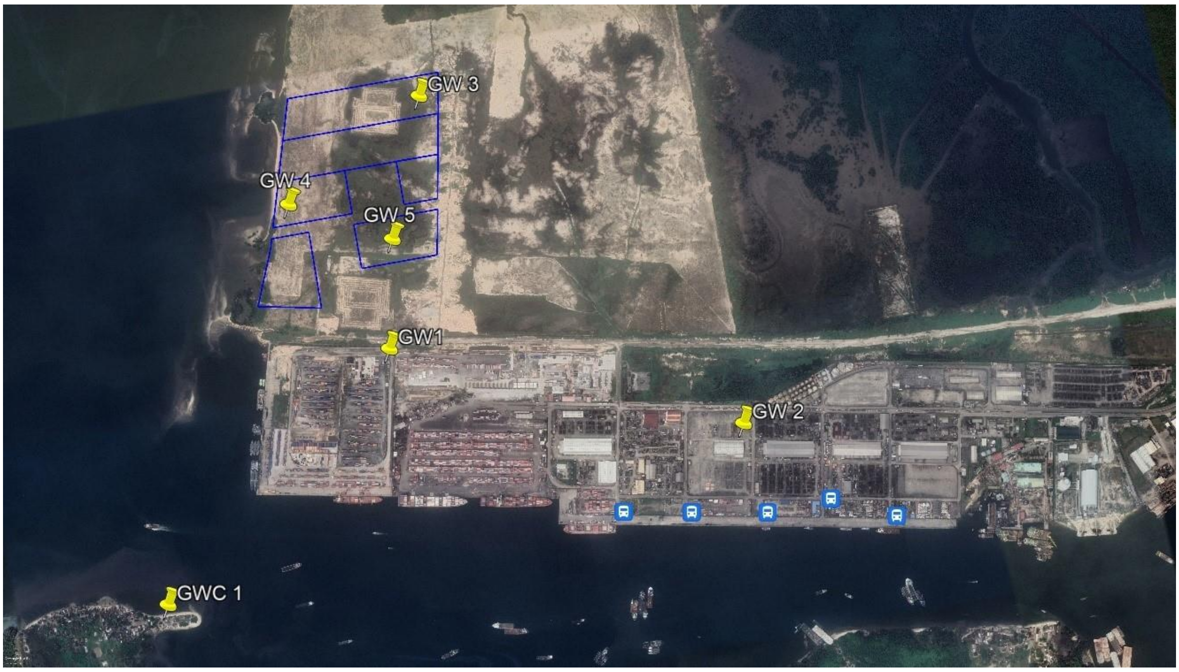


Figure 4-24: Groundwater Sampling Position Map (ECSL-b, 2023).

Results from the chemical analysis of the groundwater samples are summarised in Table 4-19. The results, as interpreted by ECSL (Environmental and Chemical Services Limited - b, 2023) are summarised below.

Groundwater sampled had pH values ranging from 6.20 to 7.70 with an average value of 6.94. These values indicate that the water from the Project site and its environs and control stations are slightly acidic. The results also show an average elevated electrical conductivity of 2214.4mS/cm and a total dissolved solids (TDS) mean of 1227.6mg/l in groundwater. This indicates possible intrusion of seawater. Dissolved Oxygen (DO) concentrations were within acceptable limits which indicated a reduction of oxidizable matters on the Project site. Heavy metal concentrations are below detection limits except iron and zinc content which is characteristic of groundwater in the Niger Delta region.

A comparison of regional groundwater quality as seen from boreholes GW1 and GW2 and site-specific groundwater as seen from the three boreholes drilled on site (GW3-5) reveals similar groundwater quality within the study area; however, minor differences are observed in total hardness, alkalinity and the ions having slightly higher concentrations in the newly drilled boreholes. These differences can be attributed to the depth of borehole and spread of the borehole locations around the coastal location.

Plotting the groundwater chemistry on a Piper plot (Figure 4-25) shows that the groundwater character in the area is consistently Na-Cl dominant. This suggests that all boreholes (GW3, GW4, GW5, GWC) are connected to the same aquifer. The groundwater is highly influenced by saline water intrusion into coastal aquifers.

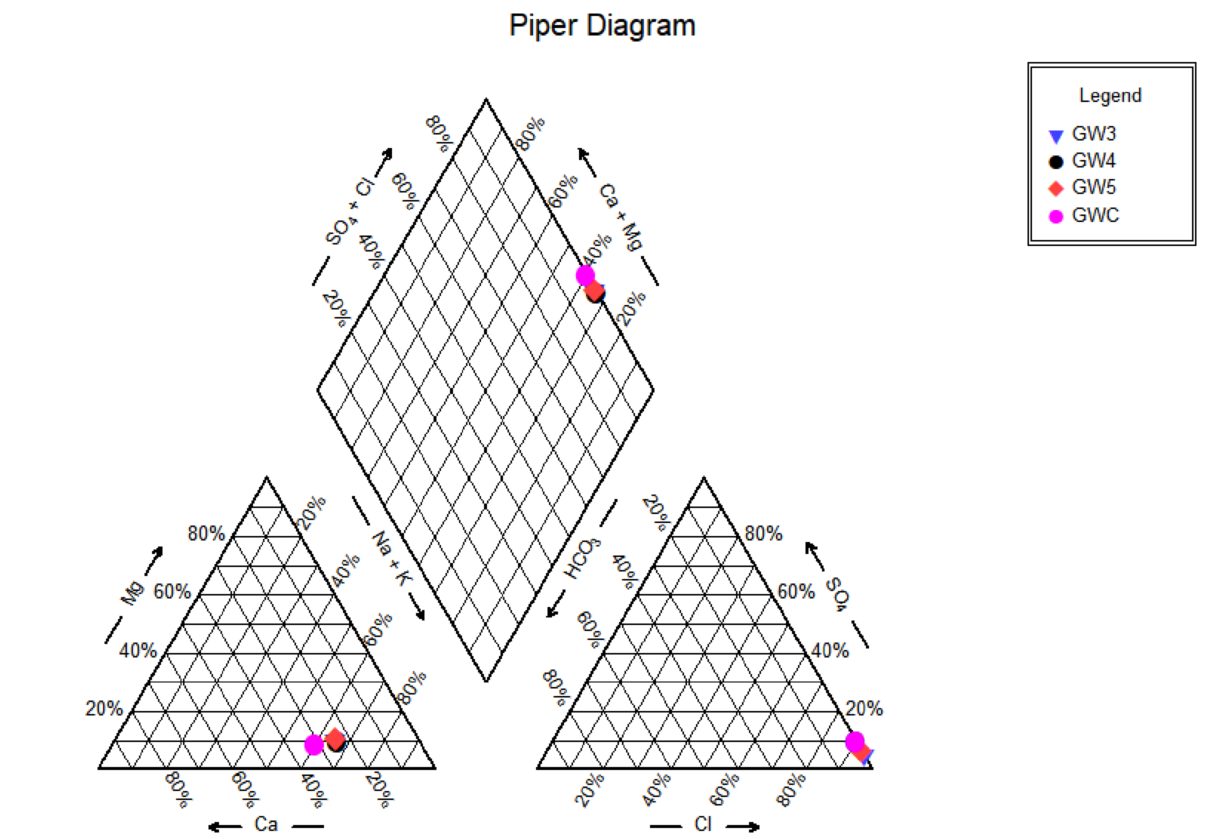


Figure 4-25: Piper Diagram of Groundwater Quality (from ECSL-b, 2023).

Table 4-20a: Groundwater Chemical Analysis Results (Wet Season – July 2023)

Parameter	GW1	GW2	GW3	GW4	GW5	GW C1	NSDWQ Limits
pH	6.70	6.20	7.70	7.20	6.90	6.30	6.5-8.5
Temperature (^oC)	27.6	27.6	27.7	27.8	27.6	26.8	NS
Appearance	Clear	Clear	Clear	Clear	Clear	Clear	NS
Elec. Conductivity (µs/cm)	663	89	2580	6320	1420	63	1000
TDS (mg/l)	404	54	1420	3480	780	38	500
Turbidity (NTU)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5.0
TSS (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	NS
Salinity (ppm)	$38x10^{-8}$	$4x10^{-8}$	1,89	10,06	1,482	$3x10^{-8}$	NS
Total Hardness (mg/l)	30.0	16.0	208.0	380.0	130.0	12.0	150
Alkalinity (mg/l)	12.0	6.0	20.0	24.0	16.0	8.0	NS
Chloride, Cl^- (mg/l)	58.0	18.0	380.0	702.0	230.0	14.0	250
Sulphate, SO_4^{2-} (mg/l)	10.0	4.0	25.0	100.0	20.0	2.0	100
Nitrate, NO^{3-} (mg/l)	0.82	0.45	1.28	1.67	1.13	0.29	50
Phosphate, PO_4^{3-} (mg/l)	0.15	0.16	1.20	1.45	0.75	0.13	NS
Cyanide (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.010

Parameter	GW1	GW2	GW3	GW4	GW5	GW C1	NSDWQ Limits
Ammonia (mg/l)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	NS
Urea	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	NS
Total Nitrogen (mg/l)	0.23	<0.20	0.37	0.48	0.32	<0.20	NS
Oil & Grease (mg/l)	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	NS
DO (mg/l)	5.30	5.80	5.20	4.90	5.10	5.60	NS
BOD_5 (mg/l)	<1.00	<1.00	2.00	1.60	1.40	<1.00	NS
COD (mg/l)	2.20	2.10	3.40	2.50	2.40	2.00	NS
Sodium, Na (mg/l)	24.39	7.84	145.00	278.00	89.80	6.31	200
Potassium, K (mg/l)	16.81	2.73	52.80	109.70	31.80	2.56	NS
Calcium, Ca (mg/l)	8.72	3.90	56.80	108.20	34.60	3.50	NS
Magnesium, Mg (mg/l)	1.51	0.78	13.70	24.60	9.20	0.58	20
Silver, Ag (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NS
Cobalt, Co (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NS
Manganese, Mn (mg/l)	0.127	0.086	0.182	0.243	0.157	0.101	2.0
Vanadium, V (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Nickel, Ni (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.020
Chromium, Cr (mg/l)	<0.001	0.012	0.025	0.038	0.017	0.016	0.05

Parameter	GW1	GW2	GW3	GW4	GW5	GW C1	NSDWQ Limits
Iron, Fe (mg/l)	0.125	0.108	0.246	0.295	0.119	0.137	0.30
Lead, Pb (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.010
Copper, Cu (mg/l)	0.073	<0.001	0.084	0.097	0.065	0.092	1.0
Zinc, Zn (mg/l)	0.016	0.011	0.078	0.085	0.054	0.017	3.0
Mercury, Hg (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0010
Cadmium, Cd (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0030
Arsenic, As (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.010
HUB (CFU/ml) x 10^2	NIL	0.2	0.2	0.4	0.1	NIL	NS
HUF (CFU/ml) x 10^2	NIL	NIL	NIL	NIL	NIL	NIL	NS
THB (CFU/ml) x 10^2	1.0	1.8	1.4	1.7	1.1	1.3	NS
THF (CFU/ml) x 10^2	NIL	NIL	NIL	NIL	NIL	NIL	NS
SRB (MPN/100ml)	0	0	0	0	0	0	NS
Fecal Coliform (MPN/100ml)	12	16	10	26	18	4	0
Total Coliform (MPN/100ml)	120	140	90	180	150	32	10
*NS- Not Stated							

Source: ECSL 2023 field sampling

Table 4-20b: Groundwater Chemical Analysis Results (Dry Season – January 2024).

Parameter	GW1	GW2	GW3	GW4	GW5	GW C1	NSDWQ Limits
pH	6.90	6.70	7.60	7.40	7.00	6.80	6.5-8.5
Temperature (^{o}C)	28.6	28.3	28.5	28.6	28.9	28.7	NS
Appearance	Clear	Clear	Clear	Clear	Clear	Clear	NS
Elec. Conductivity (µs/cm)	769	113	3,430	6,688	1573	108	1000
TDS (mg/l)	434	65	1925	3763	887	67	500
Turbidity (NTU)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	5.0
TSS (mg/l)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	NS
Total Hardness (mg/l)	43.0	25.0	288.0	450.0	180.0	20.0	150
Alkalinity (mg/l)	20.0	14.0	32.0	36.0	22.0	16.0	NS
Chloride, Cl^- (mg/l)	64.0	28.0	489.0	807.0	307.0	22.0	250
Sulphate, SO_4^{2-} (mg/l)	14.0	8.0	42.0	118.0	25.0	4.0	100
Nitrate, NO^{3-} (mg/l)	0.95	0.72	1.39	2.83	2.59	1.39	50
Phosphate, PO_4^{3-} (mg/l)	0.21	0.26	1.58	1.56	0.82	0.22	NS
Cyanide (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.010
Ammonia (mg/l)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	NS
Urea	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	NS

Parameter	GW1	GW2	GW3	GW4	GW5	GW C1	NSDWQ Limits
Total Nitrogen (mg/l)	0.32	0.27	0.52	0.76	0.45	0.25	NS
Oil & Grease (mg/l)	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	NS
DO (mg/l)	4.80	4.60	4.50	4.30	4.70	4.30	NS
BOD_5 (mg/l)	2.10	2.50	3.00	3.60	2.30	2.90	NS
COD (mg/l)	4.70	4.90	7.50	8.50	4.50	2.50	NS
Sodium, Na (mg/l)	29.43	12.72	182.50	332.80	118.80	12.61	200
Potassium, K (mg/l)	16.48	5.67	62.43	97.35	33.18	3.75	NS
Calcium, Ca (mg/l)	13.41	7.39	81.68	126.82	48.73	5.42	NS
Magnesium, Mg (mg/l)	2.22	1.37	19.86	31.58	13.76	1.49	20
Silver, Ag (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NS
Cobalt, Co (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NS
Manganese, Mn (mg/l)	0.075	0.029	0.158	0.208	0.112	0.131	2.0
Vanadium, V (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Nickel, Ni (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.020
Chromium, Cr (mg/l)	<0.001	<0.001	0.017	0.021	0.011	0.010	0.05
Iron, Fe (mg/l)	0.143	0.116	0.256	0.275	0.143	0.125	0.30
Lead, Pb (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.010

Parameter	GW1	GW2	GW3	GW4	GW5	GW C1	NSDWQ Limits
Copper, Cu (mg/l)	<0.001	<0.001	0.027	0.033	0.280	0.140	1.0
Zinc, Zn (mg/l)	0.028	0.080	0.065	0.108	0.031	0.027	3.0
Mercury, Hg (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0010
Cadmium, Cd (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.0030
Arsenic, As (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.010
HUB (CFU/ml) x 10^2	0.1	0.1	0.3	0.2	0.2	0.1	NS
HUF (CFU/ml) x 10^2	NIL	NIL	NIL	NIL	NIL	NIL	NS
THB (CFU/ml) x 10^2	1.2	1.5	1.1	1.5	1.0	1.4	NS
THF (CFU/ml) x 10^2	NIL	NIL	NIL	NIL	NIL	NIL	NS
SRB (MPN/100ml)	0	0	0	0	0	0	NS
Fecal Coliform (MPN/100ml)	4	6	6	14	12	2	0
Total Coliform (MPN/100ml)	46	32	24	82	68	14	10
*NS- Not Stated							

Source: ECSL 2024 field sampling

4.4.9.7 Groundwater Vulnerability

The groundwater level in the unconfined aquifer is relatively shallow, ranging between 3.12 and 4.14m below surface. Due to the unconfined nature of the aquifer contaminants spilled on surface can easily enter the aquifer. The high aquifer transmissivity will ease the spread of contamination through the aquifer. Based on the above, the aquifer vulnerability is rated as high.

4.4.10 Surface Water

4.4.10.1 Site Drainage

The sub-catchment within which the Site is located, is drained by the Bonny River, which forms the southern site boundary. To the east of the site, a channel to the Bonny River drains the area. Both the Bonny River and the channel are under tidal influence.

The Bonny River is located on the immediate eastern flank of the Niger Delta between longitudes 7^{o}00' and 7^{o}15'E and latitudes 4^{o}25' and 4^{o}50 ((Environmental and Chemical Services Limited - e, 2023). The strategic location of the river serves as an entrance point to the Port Harcourt and Onne ports in Rivers State. Immediately east of the river is the Bonny barrier island. The mouth of the river is jointly shared by the Caw throne channel and the New Calabar River. The width of the mouth of the river is over 13.8km and drains a total area of 621,351km^2. It has an estimated area of 206km^2 and extends 7km offshore to an average depth of about 7.5m.

The Bonny River is characterised by deep and shallow channels with semi diurnal tides that generate tidal current in phase with the tidal direction. The morphology is shaped by high tidal oscillations superimposed on waves and sediments brought in by tributaries and creeks that flow into their drainage basins. The Bonny River is further characterised with strong currents, sandbars, and erosion. The land-water interchange is relatively extensive and more intimately connected with the surrounding land (Environmental and Chemical Services Limited - e, 2023).

4.4.10.2 Surface Water Flow Characteristics

The Bonny River is a brackish tidal water body which flows and ebb in both directions into Bonny channel. During low tide the Bonny River flows in a south-westerly direction towards the ocean, while during high tide the river flow direction reverses to be northbound (inland) under tidal influence.

The flow rate of the Bonny Channel, which receives Atlantic Ocean water, has increased due to dredging which was done to increase the depth of ship lines, and for shore reclamation. The water flow was measured during surface water sampling using a float and stopwatch. The flow rate is calculated to be between 0.9 and 1.5m/s, with an average of 1.19m/s.

4.4.10.3 Surface Water Availability

The water availability of the Bonny River is relatively high, and water can be used for navigation of marine vessels without significant harm to ecosystem and other users. The Bonny River is a perennial water body which receives the Atlantic Ocean water. It consists of the main river channel with large numbers of associated creeks and creek-lets (Environmental and Chemical Services Limited - e, 2023).

4.4.10.4 Surface Water Users and Co-dependent Habitats

The numerous anthropogenic activities (oil and gas companies, import and export logistics, sand mining/dredging, waste dump) are performed in and around the Bonny River. The dredging activities/bed sweeping are required to maintain the channel depth, which has modified the Bonny River's characteristics. The Bonny River is used for navigation of marine vessels, while settlements (communities) at and nearby the Bonny River are involved in fishing activities. However, the Federal Authorities have limited access to Port influence zone (Environmental and Chemical Services Limited - e, 2023).

4.4.10.5 Surface Water Quality

Surface water quality is characterised from the results of chemical analysis of a total of 12 surface water samples. A total of 10 samples were collected within influence zone of the proposed Project from the Bonny River, and a further two samples were collected as control samples. The samples were taken along the course of the river, upstream and downstream of the proposed Project site. The sampling position details are summarised in Table 4-20, and the sampling map is shown in Figure 4-26, while surface water chemistry is presented in table 4.21a and 4.21b for wet and dry season respectively,. Please note, there is no national water standard in Nigeria for the marine environment against which the surface water physiochemical properties can be measured.

Table 4-21: Surface water sampling positions (from ECSL, 2023).

Sampling point	North	East
SW1	4°39'39.2"N	7° 08'50.5"E
SW2	4°39'55.9"N	7° 08'24.5"E
SW3	4°40'02.8"N	7° 08'10.1"E
SW4	4°40'07.0"N	7° 07'47.2"E
SW5	4°40'14.6"N	7° 07'28.8"E
SW6	4°39'59.6"N	7° 09'14.7"E
SW7	4°40'29.6"N	7° 09'22.3"E
SW8	4°40'28.9"N	7° 07'00.7"E
SW9	4°40'24.7"N	7° 06'.45.7"E
SW10	4°39'30.0"N	7° 08'03.6"E
SWC1	4°36'38.0"N	7° 10'35.3"E
SWC2	4°42'44.4"N	7° 05'39.9"E

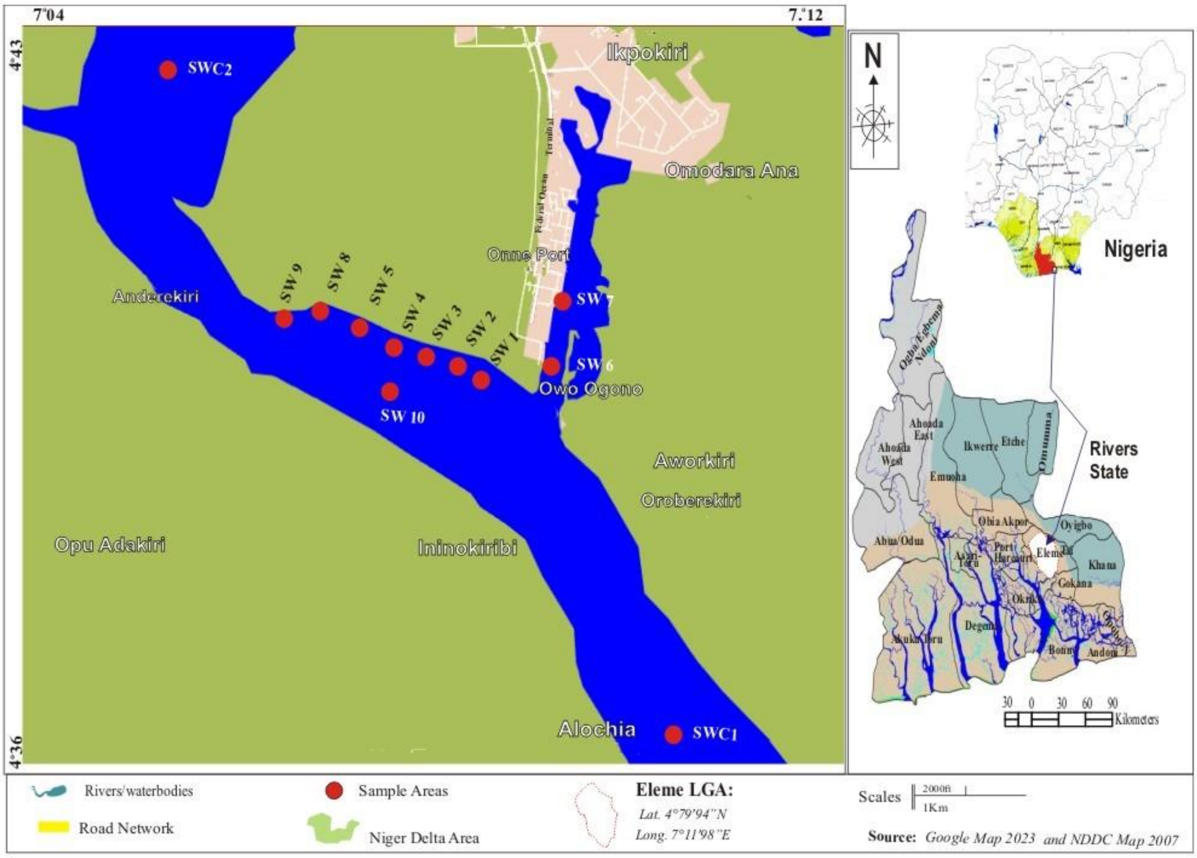


Figure 4-26: Surface Water Sampling Positions (from ECSL, 2023).

The water quality in the Bonny River is influenced by anthropogenic activities and tidal effect. The pH was slightly alkaline for all stations sampled (Environmental and Chemical Services Limited - e, 2023). The high electrical conductivity (sampling was undertaken at low tide) is attributed to high ions and salinity concentrations in the water body coupled with the tidal directional flow and is a reflection of the true nature of the waterbody. Salinity levels could be higher during high tide when flows are reverse to be from the ocean towards the inland, depending on the ocean surge.

The moderate alkalinity value of surface water could be linked to the type of dissolved inorganic and organic compounds present in the water, the amount of suspended organic matter in the water, and the amount of bicarbonate in the water (Environmental and Chemical Services Limited - e, 2023).

The BOD and COD values observed across all sampled stations including the control stations is considered to be representative of the use of the shores as industrial sites and the associated surface run-off in the study area. Heavy metal concentrations are generally low.

Generally, the Bonny River is brackish during both wet and dry season; high and low tide (Environmental and Chemical Services Limited - e, 2023). The water quality in the Bonny River is relatively similar for both seasons (Environmental and Chemical Services Limited - e, 2023).

Table 4-22a: Surface Water Chemical Analysis Results (Wet Season – July 2023)

Parameter(s)	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8	SW 9	SW 10	SWC 1	SWC 2
Depth (meters)	4.8	4.3	6.5	4.0	3.5	6.0	8.7	8.9	5.2	6.5	9.2	7.9
pH	7.60	7.60	7.50	7.60	7.65	7.50	7.55	7.65	7.40	7.60	7.60	7.70
Appearance	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Temperature (^oC)	27.4	27.3	27.3	27.4	27.4	27.4	27.3	27.4	27.4	27.4	27.1	27.1
Elec. Conductivity (µs/cm)	18.900	19.592	20.980	20.591	19.972	20.261	19,718	20.300	20.439	20.891	21.400	15.783
TDS (mg/l)	10.395	10.776	11.539	11.325	10.985	11.144	10.845	11.165	11.241	11.490	11.770	8.681
Turbidity (NTU)	7.2	7.4	6.7	6.1	6.5	12.2	16.7	7.3	8.4	9.2	7.8	10.4
TSS (mg/l)	6.0	6.3	6.4	5.2	4.9	10.9	13.8	6.1	6.9	7.7	6.6	9.1
Salinity (ppt)	8.85	9.61	10.93	10.42	9.85	9.92	9.68	12.19	10.13	10.98	9.78	7.89
Total Hardness (mg/l)	1280.0	1260.0	1220.0	1200.0	1230.0	1290.0	1220.0	1180.0	1190.0	1260.0	1240.0	1090.0
Alkalinity (mg/l)	65.0	60.0	60.0	65.0	70.0	85.0	90.0	65.0	55.0	60.0	75.0	50.0
Chloride, Cl^- (mg/l)	6.130	6.150	6.250	6.220	6.120	6.100	6.080	6.190	6.200	6.160	6.300	5.560
Sulphate, SO_4^{2-} (mg/l)	380	410	350	380	430	370	350	400	450	360	590	340
Phosphate, PO_4^{3-} (mg/l)	1.25	1.60	1.52	1.45	1.32	1.20	1.18	1.30	1.40	1.25	1.86	1.35
Nitrate, NO^{3-} (mg/l)	2.60	2.80	2.50	2.50	2.20	3.20	2.90	2.00	2.20	2.70	3.20	2.60
Cyanide (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Parameter(s)	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8	SW 9	SW 10	SWC 1	SWC 2
Ammonia (mg/l)	0.20	0.20	0.10	0.30	0.20	0.40	0.40	0.30	0.30	0.30	0.20	0.50
Urea	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Total Nitrogen (mg/l)	4.98	5.27	5.21	5.37	5.29	6.25	6.86	5.08	5.37	5.16	5.47	6.58
Oil & Grease (mg/l)	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
DO (mg/l)	4.56	5.21	5.76	4.92	5.38	5.26	5.11	5.60	5.48	5.10	6.24	6.01
BOD_5 (mg/l)	9.20	10.10	9.70	9.20	8.50	10.50	8.9	8.7	9.0	8.5	8.7	9.8
COD (mg/l)	31.80	33.70	30.60	32.4	29.8	36.5	38.3	30.6	27.6	30.6	32.1	28.5
Sodium, Na(mg/l)	3492.32	3526.8	3565.8	3576.6	3526.5	3459.74	3494.93	3593.76	3594.09	3529.44	3701.90	3190.74
Potassium, K (mg/l)	215.66	200.58	205.65	201.69	196.65	219.65	212.27	202.64	205.12	195.35	201.78	194.21
Calcium, Ca (mg/l)	275.07	276.52	275.45	274.52	278.43	276.41	271.87	270.93	274.00	271.03	273.12	233.74
Magnesium, Mg (mg/l)	125.31	122.01	119.25	117.28	120.31	131.71	119.84	113.84	115.12	118.25	124.15	112.10
Silver, Ag (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt, Co (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese, Mn (mg/l)	0.128	0.098	0.117	0.129	0.112	0.192	0.215	0.097	0.064	0.107	0.152	0.101
Vanadium, V (mg/l)	<0.001	<0.001	<0.001	<0.00	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel, Ni (mg/l)	0.029	0.032	0.026	0.025	0.029	0.078	0.092	0.03	0.022	0.029	0.036	0.019
Chromium, Cr (mg/l)	0.018	0.014	0.013	0.072	0.055	0.082	0.091	0.018	0.019	0.045	0.052	0.017

Parameter(s)	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8	SW 9	SW 10	SWC 1	SWC 2
Iron, Fe (mg/l)	0.176	0.138	0.129	0.165	0.176	0.259	0.268	0.113	0.122	0.124	0.143	0.090
Lead, Pb (mg/l)	0.011	0.009	0.014	0.012	0.017	0.058	0.065	0.012	0.016	0.026	0.035	<0.001
Copper, Cu (mg/l)	0.045	0.083	0.078	0.042	0.063	0.170	0.264	0.082	0.064	0.116	0.142	0.058
Zinc, Zn (mg/l)	0.129	0.170	0.191	0.086	0.098	0.199	0.174	0.102	0.132	0.153	0.283	0.138
Mercury, Hg (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium, Cd (mg/l)	0.015	0.012	0.016	0.036	0.087	0.068	0.060	0.037	0.084	0.110	0.144	0.042
Arsenic, As (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
HUB (CFU/ml) x 10^2	1.0	0.4	0.9	0.6	0.5	0	0.3	0.6	0.2	0.4	0.5	0.2
HUF (CFU/ml) x 10^2	0.6	0.1	0.5	0.2	0.4	NIL	NIL	0.1	0.2	0.1	0.1	0.2
THB (CFU/ml) x 10^2	2.2	1.4	2.6	1.8	2.7	2.3	1.9	1.4	1.8	2.9	2.4	2
THF (CFU/ml) x 10^2	1.6	0.3	1.7	0.4	0.8	0.3	0.2	0.3	0.7	0.3	0.3	0.6
SRB (MPN/100ml)	3	0	0	0	0	0	0	0	0	0	0	0
Fecal Coliform (MPN/100ml)	210	4	7	6	4	3	9	3	6	9	28	64
Total Coliform (MPN/100ml)	1,100	43	150	11	9	16	21	37	24	29	290	460

Source: ECSL 2023 field sampling

Table 4-21b: Surface Water Chemical Analysis Results (Dry Season – January 2024).

Parameter(s)	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8	SW 9	SW 10	SWC 1	SWC 2
Depth (meters)	5.1	4.6	6.4	4.4	3.9	6.2	8.5	9.4	5.9	6.8	10.1	8.6
pH	7.60	7.80	7.50	7.90	7.70	7.70	7.90	7.75	7.80	7.70	7.80	7.40
Appearance	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear	Clear
Temperature (^oC)	28.8	28.7	28.8	28.8	28.7	28.7	28.7	28.8	28.5	28.5	28.6	28.6
Elec. Conductivity (µs/cm)	28,760	25,300	27,200	27,100	26,400	25,600	26,200	26,900	25,000	25,400	29,400	27,500
TDS (mg/l)	16,106	14,168	15,232	15,176	14,784	14,336	14,672	15,064	14,000	14,224	16,464	15,400
Turbidity (NTU)	5.6	5.3	5.5	6.1	5.4	5.9	6.1	6.3	5.8	5.9	5.2	5.8
TSS (mg/l)	4.7	4.1	4.5	4.9	4.1	5.0	5.2	5.2	4.7	5.1	4.1	4.7
Salinity (ppt)	13.54	12.47	14.19	13.73	13.22	12.58	12.89	16.17	12.45	13.57	13.75	13.76
Total Hardness (mg/l)	1,880	1,640	1,680	1,810	1,720	1,880	1,630	1,680	1,740	1,900	2,370	2,040
Alkalinity (mg/l)	75.0	65.0	60.0	70.0	55.0	65.0	85.0	80.0	75.0	90.0	110.0	95.0
Chloride, Cl^- (mg/l)	9,030	9,210	9,670	9,480	9,420	9,670	9,120	9,670	9,120	9,060	10,320	9,670
Sulphate, SO_4^{2-} (mg/l)	320	380	440	410	430	425	480	430	470	400	750	460
Phosphate, PO_4^{3-} (mg/l)	1.37	1.21	1.78	1.75	1.65	1.82	1.75	1.59	1.96	1.81	2.68	2.13
Nitrate, NO^{3-} (mg/l)	3.57	3.34	3.73	3.52	3.42	3.35	3.85	3.59	4.51	3.94	4.76	4.27
Cyanide (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Parameter(s)	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8	SW 9	SW 10	SWC 1	SWC 2
Ammonia (mg/l)	0.30	0.35	0.25	0.40	0.30	0.30	0.35	0.40	0.35	0.40	0.45	0.50
Urea	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Total Nitrogen (mg/l)	5.86	5.92	5.73	6.15	6.55	6.08	5.88	6.33	6.12	5.95	6.73	6.45
Oil & Grease (mg/l)	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
DO (mg/l)	4.92	4.18	4.38	4.73	4.39	4.36	4.28	4.47	4.58	4.42	4.51	4.25
BOD_5 (mg/l)	12.60	13.80	11.80	13.80	14.50	10.90	10.70	12.80	13.10	12.40	12.60	14.80
COD (mg/l)	37.50	39.50	40.50	36.20	33.60	38.80	40.50	40.80	38.60	37.40	41.80	42.70
Sodium,Na (mg/l)	4956.39	5176.85	5465.87	5286.62	5264.59	5359.74	5194.93	5433.76	5094.09	5029.44	5787.90	5329.74
Potassium, K (mg/l)	415.66	400.58	405.65	401.69	396.65	419.65	412.27	402.64	405.12	395.34	401.78	394.21
Calcium, Ca (mg/l)	421.75	411.33	458.73	415.17	413.31	421.73	411.32	423.52	418.71	424.17	573.12	510.81
Magnesium, Mg (mg/l)	195.13	145.31	125.81	183.12	164.32	196.12	143.31	149.12	165.11	200.21	224.15	181.13
Silver, Ag (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt, Co (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Manganese, Mn (mg/l)	0.197	0.188	0.211	0.206	0.195	0.118	0.186	0.125	0.156	0.176	0.224	0.203
Vanadium, V (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel, Ni (mg/l)	0.034	0.038	0.036	0.045	0.039	0.068	0.079	0.047	0.052	0.061	0.091	0.039
Chromium, Cr (mg/l)	0.018	0.028	0.021	0.017	0.019	0.015	0.018	0.015	0.023	0.021	0.032	0.016

Parameter(s)	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8	SW 9	SW 10	SWC 1	SWC 2
Iron, Fe (mg/l)	0.137	0.148	0.128	0.175	0.144	0.164	0.203	0.113	0.126	0.172	0.188	0.114
Lead, Pb (mg/l)	0.015	0.012	0.011	0.017	0.019	0.032	0.045	0.023	0.025	0.032	0.049	0.018
Copper, Cu (mg/l)	0.280	0.180	0.170	0.133	0.243	0.213	0.175	0.210	0.213	0.170	0.282	0.231
Zinc, Zn (mg/l)	0.210	0.215	0.233	0.180	0.203	0.233	0.105	0.252	0.218	0.126	0.296	0.208
Mercury, Hg (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Cadmium, Cd (mg/l)	0.033	0.042	0.033	0.028	0.024	0.021	0.017	0.028	0.019	0.042	0.159	0.063
Arsenic, As (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
HUB (CFU/ml) x 10^2	1.6	0.8	1.1	0.8	0.8	0.5	0.6	0.9	0.4	0.7	0.8	0.4
HUF (CFU/ml) x 10^2	0.9	0.3	0.7	0.4	0.5	0.2	0.3	0.4	0.7	0.3	0.4	0.7
THB (CFU/ml) x 10^2	2.7	1.8	2.9	2.4	3.2	2.8	2.6	2.1	2.6	3.5	2.9	2.7
THF (CFU/ml) x 10^2	1.9	0.9	1.8	0.6	1.4	0.7	0.9	1.2	1.5	0.8	0.7	1.1
SRB (MPN/100ml)	4	0	0	0	6	0	0	2	0	0	0	3
Fecal Coliform (MPN/100ml)	180	14	12	18	16	12	20	12	22	28	24	44
Total Coliform (MPN/100ml)	960	54	180	34	40	32	48	64	84	88	168	290

Source: ECSL 2024 field sampling

4.4.11 Summary of Key Physical Environmental Sensitivities

- The geology underlying the site mainly consist of unconsolidated sand. Due to the loose sandy nature of the geology, the geology can be classified as sensitive to impacts from dredging and installation of the bored piles.
- As part of the Onne Port complex, which contains more than two hundred companies, the property is designated as an industrial area. The Onno Port Complex has been zoned as an industrial area for years and access is controlled. No land use change will take place in future.
- The soil on site is reclaimed with river sand, which dominates soil aggregates, making it friable both at wet and dry. The soils are sensitive to:
- Contamination from chemical and hydrocarbon spills on surface. Due to the relatively high permeability of the soil contamination can easily enter the soil and migrate away from the pollution source at a relatively high velocity, thereby further impacting the soils away from the pollution source.
- Shallow excavations during construction of surface infrastructure can disturb the soil structure and increase soil erosion.
- The groundwater in the area is associated with the unconsolidated sandy layers of the deltaic aquifer. The groundwater level is shallow at between 0 and 9 m depth. The aquifers are sensitive to:
- Groundwater abstraction: It is planned that two water supply wells will be installed, and it is estimated that $10m^3$/day will be used for potable water, and $8m^3$/day for service water. These volumes are relatively low and is not expected to have a notable impact on the overall groundwater availability in the sub-catchment. However, abstraction of groundwater from these water supply wells is expected lead to a drawdown in the groundwater level in the surrounding aquifers, which in turn may lead to saltwater intrusion from the Bonny River. Sodium and chloride concentrations in the Bonny River is measured to range around 3,500mg/L and 6,200mg/L respectively, while the sodium and chloride concentrations in the aquifers are measured to be in the order of 10 – 280mg/L and 20 – 700mg/L respectively. Saltwater intrusion into an aquifer is almost impossible to mitigate and can have an impact on surrounding groundwater users as well.
- Chemical and hydrocarbon spills: During the construction phase, heavy machinery will be operational on site. The spill can enter the soil and migrate vertically into the underlying aquifers from where it will migrate away from site. The extent and severity of these impacts are expected to be relatively low, but it is likely to remain in the soil and groundwater for a prolonged period of time. Remediation will be difficult.
- The sub-catchment within which the site is located, is drained by the Bonny River, which forms the southern site boundary. The Bonny River is characterized by deep and shallow channels with semi diurnal tides that generate tidal current in phase with the tidal direction. The Bonny River is further characterized with strong currents, sandbars, and erosion. The Bonny River is sensitive to:
- Dredging: The berth pocket in front of the quay where the vessel will be moored, will be dredged to a depth of approximately 13m. The dredging will temporarily increase turbulence and suspended solids in the water, but the longer-term impact will be on the river channel shape, which could impact the flow characteristics. However, it should be noted that the area where dredging will take place measures only around 450m and is a small percentage (<1%) of the total river channel area. The natural stream flow volumes are high with natural elevated suspended solids. There are also numerous other companies in the area that already does dredging / bed sweeping, therefore, the river sensitivity to the impacts is reduced.

4.5 Biophysical Environment

4.5.1 Introduction

The Niger River Delta and associated estuaries, including the Bonny River in which the Project area is situated, are considered a hotspot of biodiversity on the western coast of Africa. The Niger River Delta forms the largest freshwater swamp of Africa, with a rich diversity of fauna and flora owing to the high niche diversity of mangroves, freshwater swamps, and rainforest. Unfortunately, climate issues and anthropogenic factors have and continue to affect vulnerable coastal ecosystems and result in the rapid decline of mangrove and other habitats[8]. In a review of studies conducted across the littoral states of the Niger Delta from 1996 to 2016, Akani et al[9]. identified "(i) anthropogenic activities; (ii) extirpation of native species by invasive or exotic species, (iii) petroleum industry activities; and (iv) the lax attitude of some governments and oil and gas companies in mainstreaming biodiversity conservation in their policy and operations" as the key driving forces in the loss of biodiversity. Of the key anthropogenic impacts on biodiversity, direct and indirect, these authors list "Slash-and-burn method of preparing farmland for cultivation; massive land-take in developing various infrastructures; urbanization; unbridled exploitation of natural resources (timber, wildlife, fish, and non-timber products), without replacement considerations; plus, a series of unhealthy traditional/cultural practices, and de-reservation of forest reserves by landlord communities. Exotics like *Nypa fruticans*, *Eichhornia crassipes*, and *Chromolaena odorata* are displacing many useful native species" as major concerns, along with the often-devastating impacts associated with local oil and gas exploitation, especially prior to stricter government regulations.

4.5.2 Terrestrial Environment

4.5.2.1 Overview and History

The IUCN[10] classifies the terrestrial component of the Niger Delta into four main ecological zones:

- Lowland forests;
- Upper freshwater riverine floodplain;
- Lower tidal floodplain comprised of estuaries, mangroves, and creeks; and
- Outer chain of barrier islands (a special dynamic and ephemeral land formation/coastal vegetation type similar to the lowland rain forest).

[8] Lemenkova P, Debeir O. (2023). Computing Vegetation Indices from the Satellite Images Using GRASS GIS Scripts for Monitoring Mangrove Forests in the Coastal Landscapes of Niger Delta, Nigeria. Journal of Marine Science and Engineering. 11(4):871. https://doi.org/10.3390/jmse11040871;
Enaruvbe, G. O., & Ige-Olumide, O. (2014). Geospatial analysis of land-use change processes in a densely populated coastal city: the case of Port Harcourt, south-east Nigeria. Geocarto International, 30(4), 441–456. doi:10.1080/10106049.2014.883435;
Ansah CE, Abu I-O, Kleemann J, Mahmoud MI, Thiel M. (2022) Environmental Contamination of a Biodiversity Hotspot—Action Needed for Nature Conservation in the Niger Delta, Nigeria. Sustainability. 14(21):14256. https://doi.org/10.3390/su142114256

[9] Akani GC, Amuzie CC, Alawa GN, Nioking A, Belema R. (2022). Factors Militating Against Biodiversity Conservation in the Niger Delta, Nigeria: The Way Out. In: Chibueze Izah, S. (eds) Biodiversity in Africa: Potentials, Threats and Conservation. Sustainable Development and Biodiversity, vol 29. Springer, Singapore. https://doi.org/10.1007/978-981-19-3326-4_22

[10] IUCN Niger Delta Panel, 2018. Developing a biodiversity conservation strategy for the Niger Delta: Integrating biodiversity considerations into SPDC's operation. Gland, Switzerland: IUCN, 2018. viii+36pp

The Project area falls entirely within the mangrove swamps of the lower tidal floodplain. However, with no protected areas in proximity of Port Harcourt and repeated impacts as mentioned above, much of vegetation present along the Bonny Channel and Port Harcourt appears to be secondary vegetation[3,11]. This can be clearly seen on the historical Google Earth images for the Project site. Whilst the Project site in the year 2002 and 2011 was still covered under mangrove and swamp forest vegetation, there was already initial clearing and wetland reclamation to the east for Port Onne (Figure 4-277). Gradually, as development increased, there is a gradual increase in sandy beaches with a reduction in mangrove cover along the Project site, with the first signs of land reclamation for further development visible from 2013 onwards, with the site being entirely cleared and the creek diverted around 2015 (Figure 4-28). Since then, limited revegetation can be observed, both on the shoreline as well as inland, which is escribed further in the subsections below, but clearly represents a completely modified terrestrial habitat.

[11] Eyoh, A., & Okwuashi, O. (2017). Spatial and Temporal Evaluation of Land Use/Land Cover Change of the Niger Delta Region of Nigeria from 1986-2016. SSRG Int. J. Geoinform. Geol. Sci, 4, 20-28.

Figure 4-27: Google Earth Screen Grabs of the Project Site (red outline) in 2002 and 2011.

Figure 4-28: Google Earth Screen Grabs of the Project Site (red outline) in 2013 and 2015, showing the Complete Modification of the Site Independent of the Project.

4.5.2.2 Methods Overview

Sampling techniques for terrestrial fauna and flora are summarised in and were applied across the study area that focused on the Project site and a buffer of 2km on the north-eastern shore of the Bonny River as shown in Figure 4-29. To compensate for evasive fauna and general use of biodiversity, as well as potential extreme but unforeseen impacts, an additional buffer of 4km outside the Project site was added in which community members were interviewed regarding biodiversity. Sampling sites for

flora and fauna are shown in green in Figure 4-29.

Figure 4-29: The Project Site (red outline) together with a 2km buffer for the Potential Project Area of Influence (blue outline) and 4km Expanded Buffer for Additional Community Interviews on Biodiversity (green outline).

4.5.2.3 Summary of Methods Used for Sampling Terrestrial Fauna and Flora

Surveys were conducted between 4 and 7 July 2023, which represents the wet season.

Flora

Quadrant method consisting of:

- At each sampling sites six quadrats at 25m intervals.
- Within each quadrant, random placement of 10x10m (for trees), 5x5m (for shrubs) and 1x1m (for herbs) sub-quadrats, as shown in Figure 4-3030.
- All species were identified either in the field using specialist knowledge or filed guides, or by way of collecting herbarium specimens.

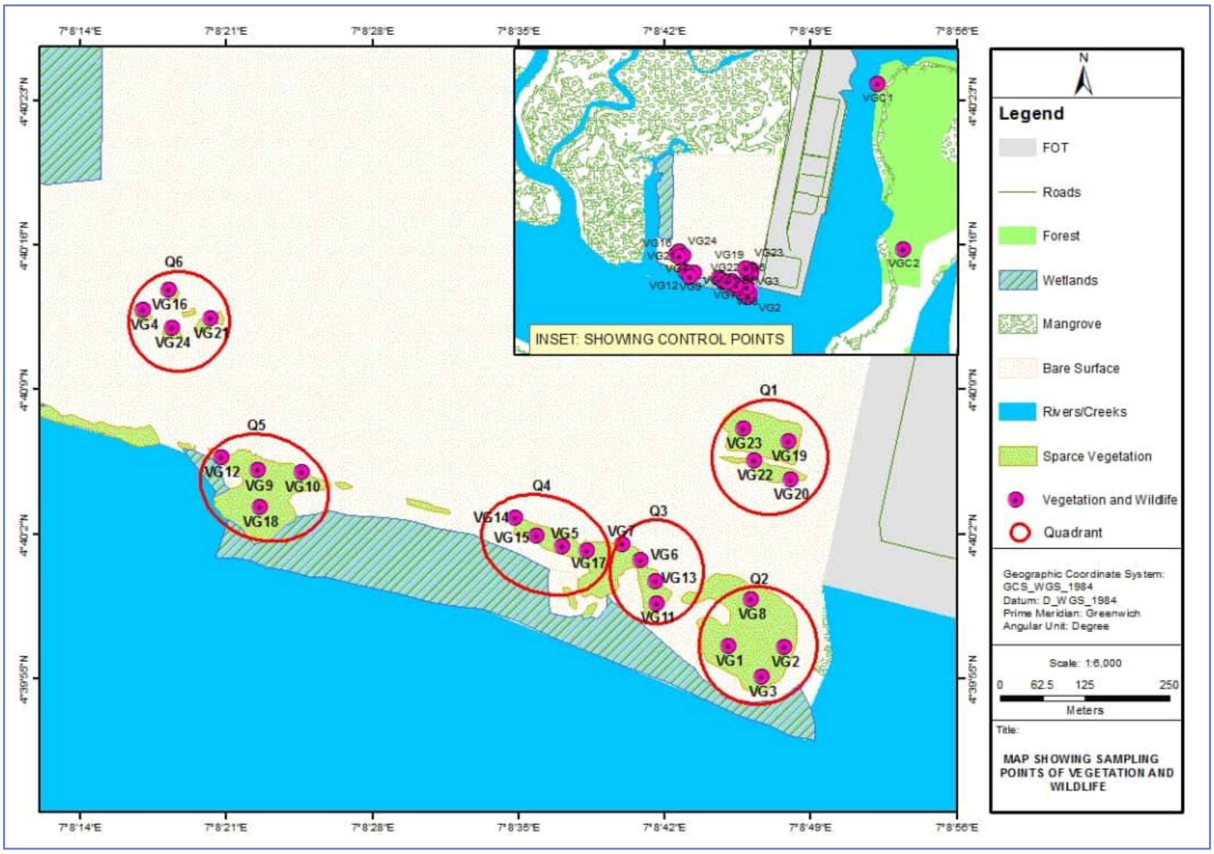


Figure 4-30a: Layout of Sampling Quadrats for Flora.

Terrestrial Fauna

The same quadrats used for flora were used for searches of fauna (direct observation) or signs of fauna (indirect observation).

- Direct Observations: Visual encounter surveys during nocturnal and diurnal expeditions and recognising evidence of wildlife species presence through vocalisation was undertaken. The capture-recapture method was used for small mammals and some invertebrate fauna. Visual encounter surveys consisted of timed habitat searches within a specified area. The number of observers, weather variables and start time of the survey was recorded and then personnel moved throughout the area, searching all potential habitats without spatially overlapping. Efforts were made not to disturb the animals seen and to avoid counting the same individual twice. Raking quadrants (2m x 2m) for litter amphibians and reptiles were also employed. Inspection of broad-leaved hydrophytes for tree frogs, lifting of stones, logs, plants, panels, plastics, etc for any hiding fauna were conducted.
- Bird species were sampled during the morning hours from 6:30am to 9:30am, which is the time that birds are generally most active in search of food and other requirements. Bird species were observed, identified, and counted opportunistically (for those flying through/across), with focused searches in niches and habitat along the transects. The same was repeated between the hours of

4 pm to 6.30 pm in the late afternoon and early evening until sunset. This is also another active period for avian species in terms of their interaction with their ecosystems.

- Indirect Observations: Indirect signs such as tracing of animals' routes/paths, scent/smell, burrows, nesting sites/nest, calls, scales, food cuttings, footprints, droppings, fur, and carcasses. Where possible, information or identification from local residents was also obtained (see below).
- **Examination of Road Kills and Meat Markets:** Interview of hunters, farmers etc. to gain better insight into, the faunal distribution pattern, seasonal migration, local names, and economic importance. The conservation status and threats to biodiversity status of species was retrieved from the IUCN Red Data List. At their homes in nearby villages, hunters were also requested to present for examination animal remains or trophies including, horns, skins, skull/skeleton, shells, hoofs, or other in their possession, as well as asked on information about the last time they sighted or killed each animal presented. Night sampling was also done to listen to the vocalization of nocturnal animals.

It must be noted that due to the intense modification of the Project site and surrounds, 60% of the checklists on mammalian, avian, amphibian and reptilian species were obtained from hunters, farmers, and gatherers of non-timber forest products (NTFPs) in the community.

4.5.2.4 Vegetation Characteristics

The study area contains modified and sand-filled areas (dominated by grasses and sedges) patches/relics of riparian mangrove vegetation, and secondary forest consisting of mangrove swamp vegetation (across the river body, about 2.3 km away for the proposed Project site).

During the survey, 85 plant species were identified and comprised of trees, shrubs, and herbs. Herbs were the dominant group of species encountered on the Project site. A concern was the high prevalence of alien invasive species within all vegetation habitats observed. A full plant species list is presented in **Annexure 4.7.** Some of the plant species identified are useful to the residents of the study area as food, medicine, construction, and general environmental sustainability. However, these species are found outside the Project site and immediate surroundings, present in the Owo-Ogono and Ele-Ogu communities that are about 3km away from the proposed Project site. The map of the relevant habitats is shown in Figure 4-31.

Modified and Sand-filled Areas

Generally, the vegetation within the proposed project site – being reclaimed and sand-filled - was dominated by grasses (*Digitaria argillacea, D. longiflora, Panicum laxum, Paspalum conjugatum* and *Eragrostis* spp.) and sedges (*Fimbristylis ferruginea* and *Mariscus ligularis*), as seen in Figure 4-32. Other herbs included the exotics *Gomphrena celosioides*, *Euphorbia heterophylla*, *Bidens pinnata*, and indigenous pioneers such as *Desmodium* spp., *Emilia praetermissa* and *Urena lobata*. Shrubs were mainly limited to the highly invasive *Chromolaena ordorata*. Also, the puff mushroom was among the species in this area (Figure 4-33). The quadrats representing this habitat were Q1, Q2, Q3 and Q6.

Figure 4-30b: Patches of Riparian Forest and Mangrove Vegetation in the Proposed Project Site. (A) Patch of Riparian Zone, (B) Tidal Plains, and (C & D) Marshy Areas.

Patches and Relics of Riparian Mangrove Vegetation

In this forest system, mangrove species are juxtaposed with non-mangrove species and swamp forest vegetation. This mosaic-modified vegetation consisting of riparian zone, sandy tidal plains and marshy areas, was found on the bank of the river of the proposed site (Figure 4-32 and Figure 4-34). This vegetation is subject to seasonal or permanent flooding by tides and river water. Characteristics species were *Rhizophora racemosa, Rhizophora mangle, Rhizophora harrisonii*, *Laguncularia racemosa, Avicennia germinans, Nypa fruticans* (alien invasive), *Acrostichum aureum*. Other plant species observed here included *Alchornea cordifolia*, *Chromolaena ordorata* (alien invasive), *Hyptis lanceolata* and *Fimbristylis* spp. Sandy beaches on the riparian fringe were commonly overgrown with *Sesuvium portulacastrum* and *Ipomoea pes-caprae* (Figure 4-36). The quadrats representing this habitat were Q4 and Q5.

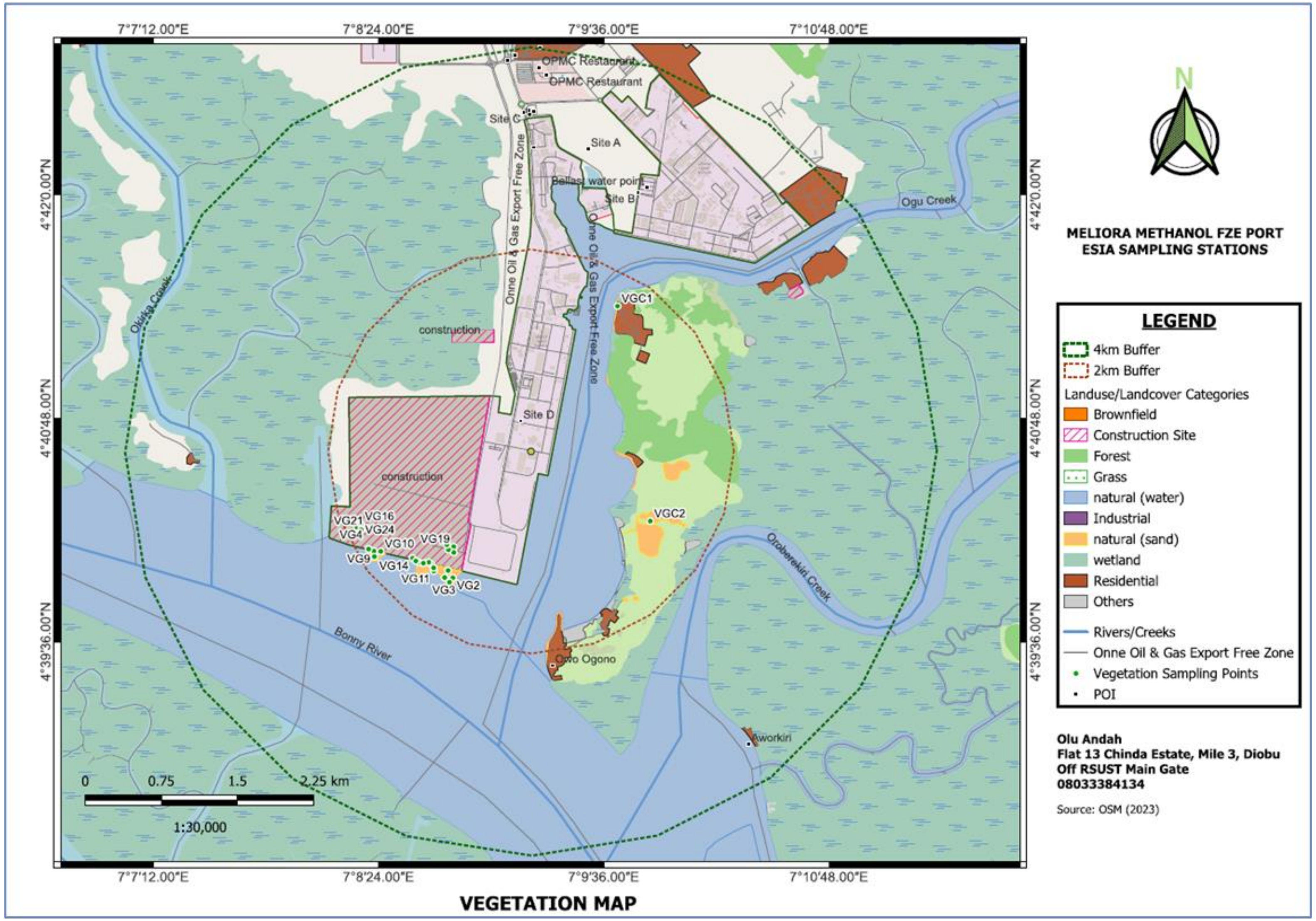


Figure 4-31: Vegetation Map Derived from the Survey.

Figure 4-32: Overview of the Vegetation Inside the Proposed Project Site.

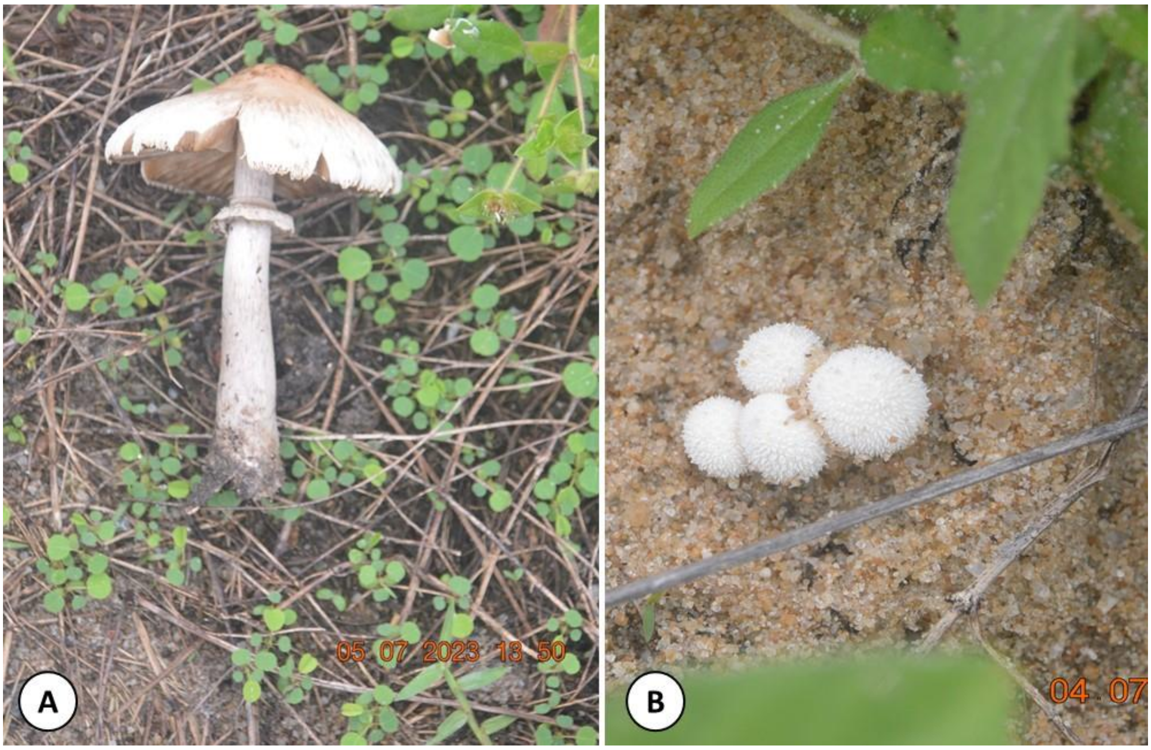


Figure 4-33: Mushrooms Observed in the Project Site.

Figure 4-34: Patches of Riparian Forest and Mangrove Vegetation in the Proposed Project Site. (A) Patch of Riparian Zone, (B) Tidal Plains, and (C & D) Marshy Areas.

Figure 4-35: Patches of Mangrove Vegetation in the Proposed Project Site.

Figure 4-36: Some Hydrophytes in the Proposed Project Site (a) *Sesuvium portulacastrum* and (b) *Ipomoea pes-caprae.*

Mangrove Swamp Vegetation

The mangrove ecosystem occupied the tidal flats in the waterways within the study area. The land system is dominated by mangrove forest. It is found on the southern periphery of the proposed Project site and near the adjoining community settlements. It is dominated by the invasive Nypa fruticans, whilst the indigenous *Rhizophora* species show zonation according to water and soil salinity levels, roughly parallel to the coast. As such *R. racemosa* was found closer to the coast, with *R. harrisonii* and *R. mangle* successively further inland. Relatively little ground vegetation occurs within the mangrove forests. The mangrove swamp forest was observed mainly at the control stations with little or small patches in quadrats. Mangrove swamps were also the dominant vegetation type fringing the banks of creek and creek-lets off Bonny River (Figure 4-37). Similar to the above riparian mangrove patches, other species included *Laguncularia racemosa, Avicennia germinans* and mangrove Salt Fern (*Acrostichum aureum).* Other non-mangrove species observed included grasses such as *Paspalum vaginatum* and the shrub *Dalbergia ecastaphyllum*. Quadrats representing this habitat were control quadrats outside the Project Site, VOC1 and VOC2.

Figure 4-37: Fringe of Mangrove and other Vegetation along the Owo-Ogono Water Ways. Note the dense Stands of Invasive Nypa Palm (arrow).

4.5.2.5 Terrestrial Fauna

Birds constituted more than 75% of the fauna species physically observed during the survey, whilst the records of the other fauna were based on interviews with hunters and workers in the adjoining facilities and villages (Figure 4-38). Further, a lot of insect species thrive in the study area, but these were not recorded in detail. In general, presence of terrestrial fauna on the Project site was very low relative to the Niger Delta diversity due to the high level of modification and disturbance. Even within the 2km buffer, suitable habitat for any threatened terrestrial fauna was extremely limited, and not within 500m of the Project site.

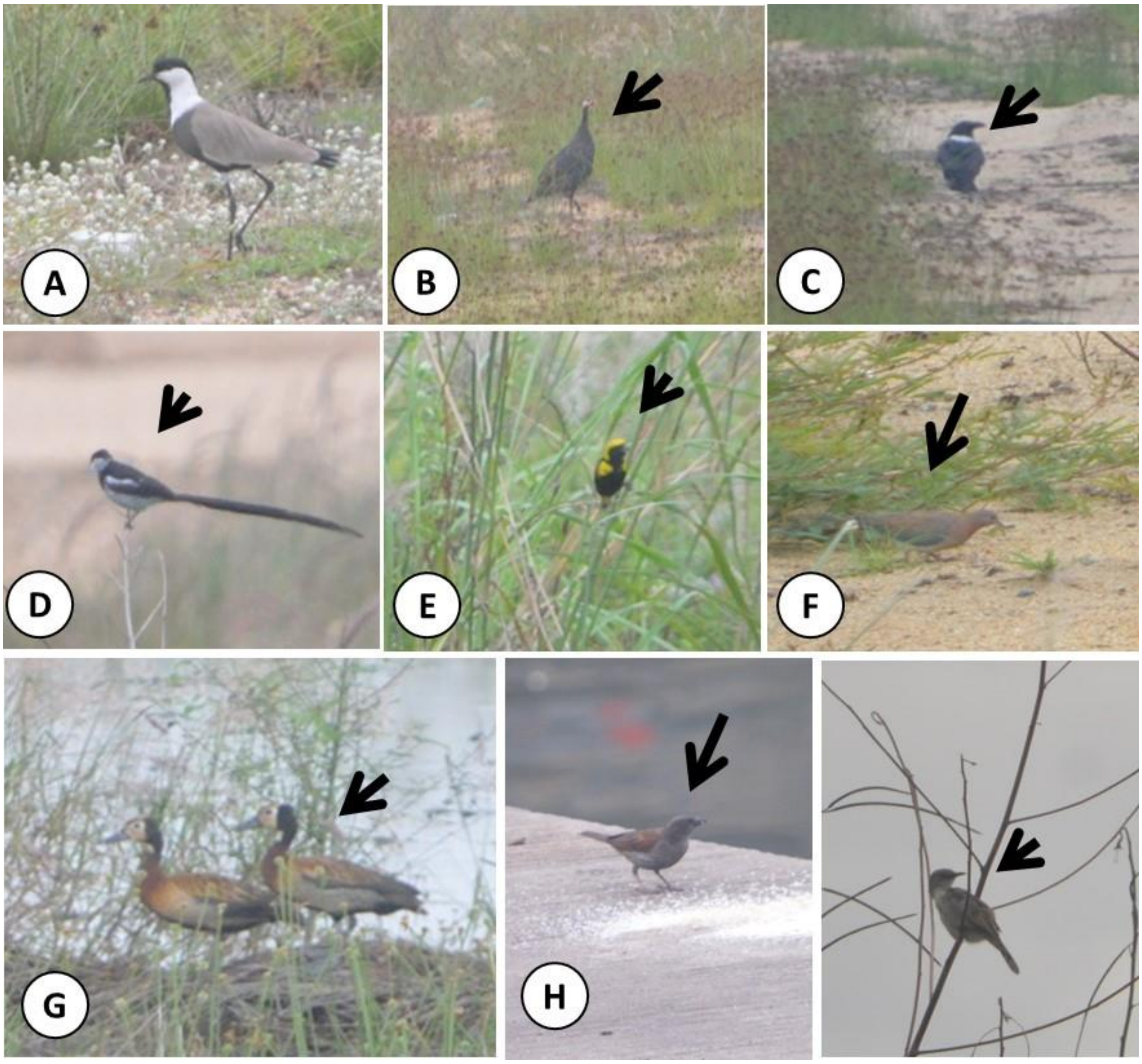


Figure 4-38a: Avian Species Observed in the Study Area (Source: Fieldwork 2023)

The lists of birds, mammals and herpetofauna observed or recorded from interviews is listed in Table 4-22, Table 4-23 and Table 4-24. Local names, where available, are in the Ongoni language. The tables also indicate threatened species – where the local threat status differs from the global IUCN status, this has been indicated.

Table 4-23: Bird Species Observed

Scientific name	Common name	Family	IUCN status	Local Names
Accipiter nisus	Eurasian Sparrowhawk	Accipitridae	LC	
Accipiter tachiro	African Goshawk	Accipitridae	LC	
Apus barbatus	African Black Swift	Apodidae	LC	
Apus caffer	White-rumped Swift	Apodidae	LC	
Bubo africanus	African Spotted Eagle-Owl	Strigidae	LC	
Bubulcus ibis	Cattle Egret	Ardeidae	LC	
Bycanistes bucinator	Trumpeter Hornbill	Bucerotidae	LC	
Calidris ferruginea	Sand Piper	Accipitridae	NT	
Chalcomitra senegalensis	Scarlet-chested Sunbird	Nectariniidae	LC	
Cinnyris cupreus	Copper Sunbird	Nectariniidae	LC	Ágyéẹ̀b
Cinnyris pulchellus	Beautiful Sunbird	Nectariniidae	LC	
Corvus albus	Pied Crow	Corvidae	LC	
Cyanomitra verticalis	Green-headed Sunbird	Nectariniidae	LC	
Dendropicos goertae	African Gray Woodpecker	Picidae	LC	
Cypsiurus parvus	African Palm Swift	Apodidae	LC	
Egretta garzetta	Little Egret	Ardeidae	LC	
Euplectes orix	Red Bishop	Ploceidae	LC	
Falcon spp.	Falcon	Falconidae	LC	
Francolinus bicalcaratus	Double-spurred Francolin	Phasianidae	LC	
Guttera sp	Guinea fowl	Numididae	LC	
Gymnoris dentata	Bush Sparrow	Passeridae	LC	
Hirundo albigularis	White-throated Swallow	Hirundinidae	LC	
Lophoceros fasciatus	African Pied Hornbill	Bucerotidae	LC	
Merops nubicus	Northern Carmine Bee-eater	Meropidae	LC	
Milvus migrans	African Black Kite	Accipitridae	LC	
Numida meleagris	Helmeted Guineafowl	Numididae	LC	
Otus senegalensis	African Scops-owl	Strigidae	LC	
Ploceus cucullatus	Village Weaver	Ploceidae	LC	
Polyboroides radiatus	Madagascan Harrier-Hawk	Accipitridae	LC	
Psittacus erithacus	**African Grey Parrot**	**Psittacidae**	**EN**	
Ptilopsis leucotis	Northern White-faced Owl	Strigidae	LC	
Pycnonotus barbatus	Common Bulbul	Pycnonotidae	LC	bẹẹ²
Quelea quelea	Red-billed Quelea	Ploceidae	LC	Ogazi
Rhyticeros cassidix	**Knobbed Hornbill**	**Bucerotidae**	**VU**	**Hnà**
Scopus umbretta	Heron Bird	Scopidae	LC	
Spilopelia senengalensis	Laughing Dove	Columbidae	LC	
Streptopelia semitorquata	Red-eyed Dove	Columbidae	LC	
Tringa spp	Sandpiper	Scolopacidae	LC	

Table 4-24: Mammal Species Recorded.

Scientific Name	Common Name	Family	IUCN Status	Local Name
Arvicanthis niloticus	The Nile Rat	Muridae	LC	
Atherurus africanus	Brush-tailed Porcupine	Hystricidae	LC	Bínàhyúu
***Cephalophus* spp**	**Duiker**	**Bovidae**	**VU (local), NT**	**Gbam**
Cercopithecus nictitans	**Putty-nosed Monkey**	**Cercopithecidae**	**EN (local), NT**	**Hwìnì**
Civettictis civetta	African Civet	Viverridae	LC	
Cricetomys gambianus	Gambian Pouched Rat	Nesomyidae	LC	
Cricetomys emini	Forest Giant Pouched Rat	Nesomyidae	LC	Lúé
Crocidura sp.	Shrew	Soricidae		
Epixerus ebii	African Palm Squirrel	Sciuridae	LC	
Epomophorus spp.	Bat	Pteropodidae		
Epomops sp.	Bat	Chiroptera	LC	
Funisciurus pyrropus	African Striped Tree Squirrel	Sciuridae	LC	
Galago sp.	Bush Baby	Galagidae	DD	
Lemniscomys spp	Spotted Grass Mouse	Muridae	LC	hyúu²
Lemniscomys striatus	Typical Striped Grass Mouse	Muridae	LC	
Micropteropus pusillus	Peter's Dwarf Epauletted Fruit Bat	Pteropodidae	LC	Byãà
Phataginus tetradactyla	**African Black-bellied Pangolin**	**Manidae**	**VU**	
Philantomba maxwellii	Antelope	Bovidae	LC	
Potamochoerus larvatus	Bush Pig	Suidae	LC	
Potamochoerus porcus	Red River Hog	Suidae	LC	Akpã
Protoxerus stangeri	African Giant Squirrel	Sciuridae	LC	
Rattus rattus	Common Rat	Muridae	Invasive	
Rattus fuscipes	Australian Bush Rat	Muridae	Introduced	
Scotophilus dinganii	African Yellow Bat	Vespertilionidae	LC	
Taphozous peli	Giant Pouched Bat	Emballonuridae	LC	
Thryonomys swinderianus	Cane Rat	Thryonomyidae	LC	Bínà
Xerus erythropus	Striped Ground Squirrel	Sciuridae	LC	

Table 4-25a: Herpetofauna Recorded

Scientific Name	Common Name	Family	IUCN Status	Local Name
Amphibians				
Amietophrynus superciliaris	African Giant Toad	Bufonidae	LC	
Sclerophrys regularis	African Common Toad	Bufonidae	LC	
Reptiles				
Agama agama	Common Agama	Agamidae	LC	Gbèrè

Scientific Name	Common Name	Family	IUCN Status	Local Name
Amblyrhynchus cristatus	**Marine Iguana**	**Iguanidae**	**VU**	**Byã**
Bitis arietans	Puff Adder	Viperidae	LC	Bom
Chamaeleo africanus	African Chameleon	Chamaeleonidae	LC	
Crocodylus niloticus	Nile Crocodile	Crocodylidae	LC	Atèkúrú
Dendroaspis jamesoni	Green Mamba	Elapidae	LC	
Gastropyxis smaradgina	Emerald Green Snake	Elapidae	LC	
Grayia smithii	Smith's African Water Snake	Grayidae	LC	
Hemidactylus kyaboboensis	Forest Gecko	Gekkonidae	LC	
Kinixys belliana	Bell's Hinge-back Tortoise	Testudinidae	LC	
Lampropholis guichenoti	Skink	Scincidae	LC	
Lycodonomorphus inornatus	Black House Snake	Lamphropiidae	LC	
Trachylepis maculilabris	Speckle-lipped Mabuya	Scincidae	LC	
Naja nigricincta	Western Barred Spitting Cobra	Elapidae	LC	
Naja nigricollis	Black-necked spitting cobra	Elapidae	LC	
Osteolaemus tetraspis	**African Dwarf Crocodile**	**Crocodylidae**	**VU**	**Pa**
Python regius	Ball Python	Phtonidae	NT	hyóọ
Python sebae	African Rock Python	Phtonidae	NT	hyóọ
Tarentola merensis	Wall Gecko	Gekkonidae	LC	
Trachylepis affinis	Senegal Mabuya	Scincidae	LC	
Trachylepis sp	Striped Skink	Scincidae	LC	
Varanus niloticus	Nile Monitor Lizard	Varanidae	LC	

Among the faunal taxa recorded, birds constituted 38 species (40%), mammalian 26 species (31%, but noting that some could only be identified to genus level and could constitute more than one species), and herpetofauna 24 species (26%). Birds are generally more frequently seen and reported by the locals. This could be attributed to the fact that they are not easily restricted by barriers.

Water bird

Ten (10) water bird species namely: *Vanellus spinosus*, *Microcarbo africanus***,** *Numenius phaeopus*, *Charadrius hiaticula***,** *Anarchynchus marginatus, Dendrocygna viduata, Actitis hypoleucos, Ardea cinerea*, *Egretta ardesiaca,* and *Egretta alba* were observed and identified within the study area. These water birds belong to four (4) families and nine (9) genera. Among these species, the juveniles of *Vanellus spinosus* ((Spur-winged Plover)*, Charadrius hiaticula* (Ringed plover), and *Microcarbo africanus* (Long-tailed cormorant) indicate that they breed within the proposed project site environment. The Some migratory water birds were observed during field survey and all the species identified are on the Least Concern (LC) status of IUCN. This report has shown that the study area inhabits some migratory water birds,

Table 4.25b List and status of water bird species observed.

S/N	Scientific name	Common Name	Family	IUCN status
1	*Vanellus spinosus*	Spur-winged Plover	Charadriidae	LC
2	*Microcarbo africanus*	Long-tailed cormorant	Phalacrocoracidae	LC
3	*Actitis hypoleucos*	Common Sand piper	Scolopacidae	LC
4	*Anarhynchus marginatus*	White-fronted Plover (Chick)	Charadriidae	LC
5	*Dendrocygna viduata*	White-faced whistling duck	Anatidae	LC
6	*Ardea cinerea*	Gray Heron	Ardeidae	LC
7	*Egretta ardesiaca*	Black heron/black egret	Ardeidae	LC
8	*Egretta alba*	Great egret/great white heron	Ardeidae	LC
9	*Numenius phaeopus*	Whimbrel	Scolopacidae	LC
10	*Charadrius hiaticula*	Ringed plover	Charadriidae	LC

All the water bird species observed and identified are in the Least Concern (LC) status.

Figure 4.38b: Photographs of the bird species observed in the proposed project site (1) *Vanellus spinosus*, (2) *Microcarbo africanus,* (3) *Numenius phaeopus,*(4) *Charadrius hiaticula*, (5) *Anarchynchus marginatus,* (6) *Dendrocygna viduata,* (7) *Actitis hypoleucos,* (8 - 9) *Ardea cinerea*, (10) *Egretta ardesiaca,* and (11) *Egretta alba.*

A: *Actitis hypoleucos* (Common Sand piper)

B: *Numenius phaeopus* (Whimbrel)

C: *Charadrius hiaticula* (Ringed plover):

D: Dendrocygna viduata

Figure 4-38c: Pictures of water bird species observed during the survey.

4.5.2.6 Conservation Concerns within the Terrestrial Biodiversity

Despite the entire Niger delta being known as a biodiversity hotspot as mentioned earlier, the closest protected areas are over 30km away from the Project Site, with no direct linkages through waterways or other ecological corridors. Similarly, the closest Key Biodiversity Area (KBA) is over 60km away from the Project site. Lastly, the closest RAMSAR wetland is over 60km to the north-west of the Project site, being the Upper Orashi Forests.

An initial screening of potential critical habitat triggering species (Table 4-25) revealed that from the flora side, those would be mostly taller trees, whilst the presence of critical-habitat-triggering terrestrial fauna would largely depend on the presence of such tall stands of trees, which have not been present since the site and surrounding areas were cleared/reclaimed for development. Following these insights, no further critical habitat investigations were undertaken, as no terrestrial critical habitat is present on or within at least 2km of the Project site.

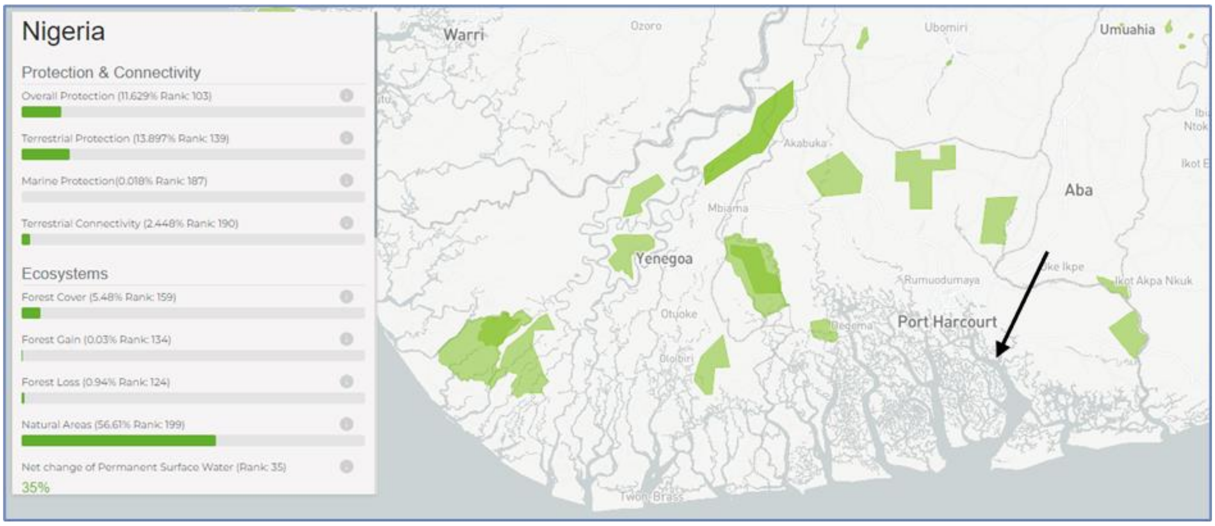


Figure 4-39: Location of the Project Site relative to Protected Areas.

Source: Digital Observatory for Protected Areas (DOPA) Explorer, accessed at https://dopa-explorer.jrc.ec.europa.eu/ on 21/09/2023

Table 4-26: Critical Habitat-triggering Species Historically Observed in the Wider Port Harcourt Area.

Species	IUCN Status	Presence on and around site
Flora		
Allanblackia gabonensis	VU	None
Dalbergia dalzieli	VU	None
Isonema buchholzii	VU	None
Khaya grandifoliola	VU	None
Khaya ivorensis	VU	None
Lophira alata	VU	None
Pterocarpus indicus	EN	None
Scaphopetalum parvifolium	VU	None

Species	IUCN Status	Presence on and around site
Talbotiella eketensis	EN	None
Vigna desmodioides	EN	None
Birds		
Aquila rapax Tawny Eagle	VU	May fly over
Malimbus ibadanensis Ibadan malimbe	EN, endemic to Nigeria	Could frequent surrounding areas, inhabits forest patches, forest edge, secondary woodland, and possibly even highly degraded farmland and gardens[12]
Necrosyrtes monachus Hooded Vulture	CR	May fly over
Polemaetus bellicosus Martial Eagle	EN	May fly over
Psittacus erithacus African Grey Parrot	EN	Confirmed flying over, but breeds and feeds in forest
Rhyticeros cassidix Knobbed Hornbill	VU	May fly over
Reptiles		
Eretmochelys imbricata Hawksbill sea turtle	CR	Highly unlikely to use shores for breeding
Osteolaemus tetraspis African Dwarf Crocodile	VU	Reported by hunters, unlikely to use shores at site for breeding or basking due to high levels of disturbance
Mammals		
Cercopithecus erythrogaster White-throated Guenon	EN	No habitat – lives on trees
Cercopithecus sclateri Sclater's Guenon	EN	No habitat – lives in forest
Phataginus tetradactyla African Black-bellied Pangolin	VU	Named by hunters from surrounding villages, but no habitat on or near site

The three species indicated in red in Table 4-25 have been reported by hunters in nearby communities, but no suitable habitat for breeding, foraging or other is present on the Project site.

4.5.3 Estuarine/ Aquatic Environment

4.5.3.1 Introduction

The Bonny River is a branch of the Niger Delta, and the estuary is one of several within the Niger Delta (Figure 4-40) (Amadi 1990, Davies and Ugwumba 2013a). The system consists of the main Bonny River channel and many associated creeks and is a maximum of 2 km wide and 15 m deep at the mouth. The Bonny River Estuary has the largest tidal volume of all of the Niger Delta rivers, and is the most affected by tidal movement, due to low elevation, relatively low freshwater input, and the configuration of the basin, which allows the tidal range to increase inland (Chindah and Braide 2004).

[12] BirdLife International (2023) Species factsheet: Malimbus ibadanensis. Downloaded from http://datazone.birdlife.org/species/factsheet/ibadan-malimbe-malimbus-ibadanensis on 21/09/2023.

The Bonny River Estuary is abundant in aquatic resources, and is made up of many creeks, tributaries, floodplains, and mangrove swamps, rich in tropical fauna and flora. The vegetation is dominated by mangrove species *Rhizophora racemosa* and *R. mangle* (Davies and Ugwumba 2013a). In general, the Bonny River Estuary is populated by similar species to those found in the other estuaries of the Niger Delta (Daka et al. 2019b).

Despite its biodiversity, the Bonny Estuary is a busy transport route for vessels and has a strong industrial presence on its banks, particularly of the petrochemical, and oil and gas service industries. These industries, and the local population, expose the estuary to a range of pressures, including sewage and industrial effluent. The Upper Bonny Estuary catchment has a high population density without waste management facilities and the runoff of this waste into the estuary have negative impacts on the system (Davies and Ugwumba 2013a, Daka et al. 2019b). The Niger Delta belongs to the largest swamp and mangrove forests in the world hosting many endemic and endangered species[13] Despite being a biodiversity hotspot, the Niger Delta region has become the main production area for oil and natural gas on the continent, and associated with this, has also become known for frequent oil spills. This deterioration of water quality has reportedly had catastrophic consequences for the environment (Akani and Luiselli 2010). In addition, within the Bonny Estuary, pollution is one of the factors that has reduced the mangrove population, which also in turn has become invaded with the alien invasive Nypa palm *Nypa fruticans* (Davies and Ugwumba 2013a, Barenblitt et al. 2023).

Figure 4-40: Map of Niger Delta Basin Showing the Location of the Bonny Estuary (Source: Okogbue et al. 2018).

[13] https://www.researchgate.net/publication/365043367_Environmental_Contamination_of_a_Biodiversity_Hotspot-Action_Needed_for_Nature_Conservation_in_the_Niger_Delta_Nigeria

4.5.3.2 Sediment Quality

Sediment quality is a measure of the extent to which the nature of benthic sediments (particle size composition, organic content, and contaminant concentrations) has been altered from its natural state. This is important as it influences the types and numbers of organisms inhabiting the sediments and is in turn, strongly affected by the extent of water movement (wave action and current speeds), mechanical disturbance (e.g. sand mining) and quality of the overlying water. Sediment parameters respond quickly to changes in the environment but are able to integrate changes over short periods of time (weeks to months) and are thus good indicators for short to very short-term changes in environmental health.

Percentage contributions of sand (63-1000µm), silt (2-63µm) and clay (<2µm) at the sediment sampling sites surveyed during the 2023 wet season in June and July 2023 are shown in Figure 4-41. Generally, all sites had a very similar particle size distribution and were predominantly sandy, with the percentage contribution of sand averaging just over 80 percent (Figure 4-41). The remaining 20 percent was mostly clay (approximately 14%) and silt (approximately 5%).

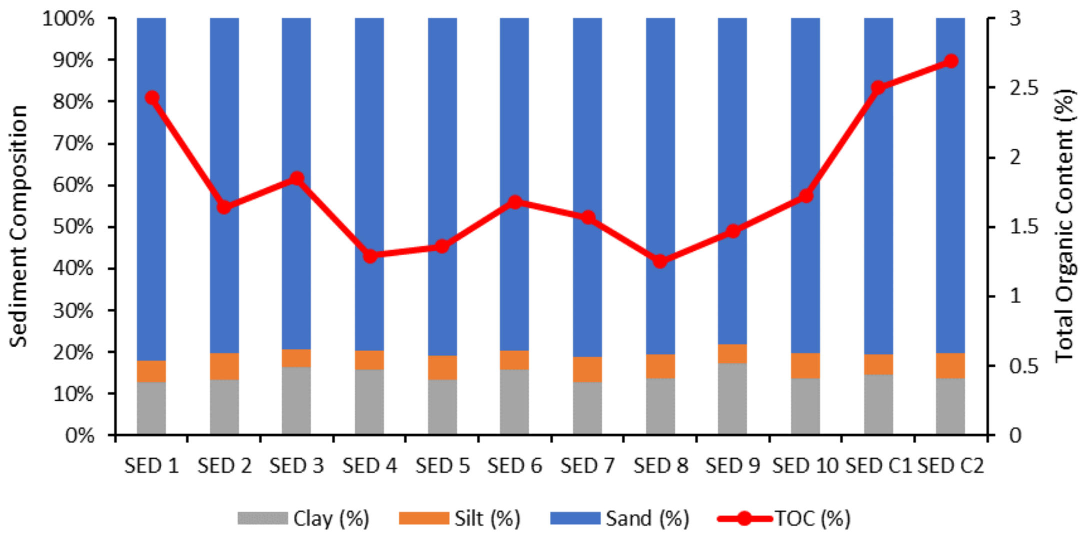


Figure 4-41: Percentage Sediment Composition and Percentage Total Organic Carbon (TOC) per Site in the Wet Season Survey (2023).

Total organic content (TOC) is a measure of the organic matter present in sediment. Organic matter, whether it is derived from marine or terrestrial origins, is an essential food source for benthic macrofaunal communities and can influence the ecological health of a system as a whole. However, the excessive loading of organic matter in sediments can have deleterious effects. Organic matter in sediments doesn't necessarily directly impact the environment, but bacterial breakdown can (and often does) lead to hypoxic (low oxygen) or even anoxic (no oxygen) conditions.

Under such conditions, anaerobic decomposition prevails, which results in the formation of sulphides such as hydrogen sulphide (H_2S). Sediments high in H_2S are characteristically black, foul smelling and toxic for most living organisms. Consequently, organic content can influence macrofaunal distribution and diversity (Bolam et al. 2004, Austen & Widdicombe 2006) causing knock-on effects through ecosystems (Pearson & Rosenberg 1978, Diaz & Rosenberg 1995, Gray et al. 2002). Furthermore, due to the cohesive nature of organic matter, levels of TOC in sediment can influence the adsorption and retention of contaminants and can therefore provide valuable insight on the possible accumulation of pollutants in sediment and resultant toxicity. Unlike the sediment particle size, organic content sampled in the Bonny Estuary during the wet season varied based on site, with the highest quantities of TOC in SW1, SWC1 and SWC2.

4.5.3.3 Macrophytes

Macrophytes are the aquatic plants that grow within or near water. They may be emergent, submerged, or floating, and provide important habitat, nesting sites, and food for other aquatic organisms. They also help to maintain nutrient levels, accumulate toxins, and regulate gaseous exchange (Gijo and Alagoa 2022). However, invasive aquatic plants such as water hyacinth, duck weed, water lettuce, and hypha grass have become widespread in the Niger Delta, which have economic and environmental consequences for these systems.

The nearby River Nun Estuary, also part of the Niger Delta, was found to have a high diversity of aquatic macrophytes, with 16 species from eight families, including nine species of mangrove. The highly invasive water hyacinth *Eichhornia crassipes* was amongst these species, as although known as a freshwater aquatic macrophyte, lower salinity conditions, such as those associated with the rainy season, may allow these plants to survive in estuaries (Gijo and Alagoa 2022).

Many of the species found in the Nun Estuary are likely to occur in the Bonny River Estuary, however, the wet season field sampling only surveyed for floating macrophytes of which none were observed. Historically, water hyacinth has been observed in the Upper Bonny Estuary during the rainy season and given the difficulty of removing these invasive species from a system it is likely they may return (Davies and Ugwumba 2013b).

4.5.3.4 Mangroves

Mangrove trees grow ubiquitously as a relatively narrow fringe between land and sea, between latitudes 30°N and 30°S. They form forests of salt-tolerant species, with complex food webs and ecosystem dynamics (Valiela et al. 2001). Destruction of mangrove forests is occurring globally. Global changes such as increased sea level may also affect mangroves (Ellison 1993, Field 1995), although accretion rates in mangrove forests are often large enough to compensate for the present-day rise in sea level (Field 1995). More important, it is human alterations created by conversion of mangroves to mariculture, agriculture, and urbanisation, as well as forestry uses and the effects of warfare, that have led to the remarkable recent losses of mangrove habitat (Valiela et al. 2001). New data on mangrove extents have become more readily available. Moreover, information about the function of mangrove swamps, their importance in the sustainability of the coastal zone, and the effect of human uses on mangrove forests is growing.

Mangrove forests make up less than 1% of total tropical forests in the world yet are one of the most productive and biologically complex ecosystems. They also store between three and four times more carbon per unit area compared to tropical forests (Murdiyarso et al. 2015, Mondal et al. 2017). Despite this, global declines of mangrove cover, from 18.8 million hectares in 1990 to 15.2 million hectares in 2005, as a result of land competition for agriculture, aquaculture, tourism and infrastructure development, has been reported (Mondal et al. 2017).

Nigeria's mangrove ecosystem is the third largest in the world, occupying 975 000 km^2 of the low-lying land fringing coastal swamps, and reaching its greatest extent in the Niger Delta (Ewa-Oboho et al. 2005). The Food and Agriculture Organization (FAO 2007) estimated that Nigeria has around 30.76% of Africa's total mangrove area, making it the country with the greatest mangrove cover in Africa, and is one of five countries making up 48% of the total global area (FAO 2007). In addition to the ecosystem services they also provide habitat for endangered species such as red colobus monkeys *Procolobus badius*, Sclaters' geunon *Cercopithecus sclateri* and Heslop's pygmy hippopotamus *Choeropsis liberiensis* (Barenblitt et al. 2023).

Local inhabitants of mangrove areas in Nigeria harvest mangroves for use as timber, fuel wood, charcoal, medicine, thatching, dyes, and other household products. Mangrove forests are also the source of food such as crabs and shrimp, honey, salt, and *Tymopanonus fuscutus* periwinkles (Abere and Ekeke 2011, Numbere 2018). Major threats to Niger Delta mangroves, including those on the Bonny River, include oil and gas exploration, deforestation, dredging and the invasive Nypa palm *Nypa fruticans* (Numbere 2018). Nypa palm outcompetes mangrove species, and replaces them, which has shown to lead to erosion. Furthermore, this species reduces nutrient cycling in mangrove regions and does not sequester carbon to the great extent that mangroves do (James et al. 2007, Barenblitt et al. 2023). The pollution and removal of mangrove forests has knock-on effects for the fauna inhabiting them, and Nypa palm invades more easily in polluted and disturbed environments (Barenblitt et al. 2023).

Of the aquatic macrophytes recorded in the nearby River Nun Estuary, nine species were mangroves, including *Avicennia germinans, A. marina, Laguncularia racemosa, Rhizophora mangle, R. racemosa, R stylosa, R. mucronata, R. africana* and *Ceriops tagal* (Gijo and Alagoa 2022). Given the proximity and similarity of habitat, it is likely that these species also make up the mangrove forests along the Bonny River Estuary. The invasive Nypa palm was also recorded amongst the macrophytes (see Figure 4-43). Additional research which tested for concentrations of heavy metals in the mangrove plants of the upper Bonny River Estuary reported that concentrations of lead, cadmium and nickel in the mangrove roots fell within and slightly above standard limits of WHO/FAO for such metals, and were higher than in the surrounding sediment (Nwoha et al. 2019). This is worth noting as the development of the proposed terminal, or dredging required for the activity may resuspend heavy metals presented sequestered in the sediment.

Mangrove forest in the study area has greatly reduced in extent since 2000, having been cleared mostly for development in Onne Port (Figure 4-42). Within the Project site, only remnants of mangrove remain (Figure 4-42).

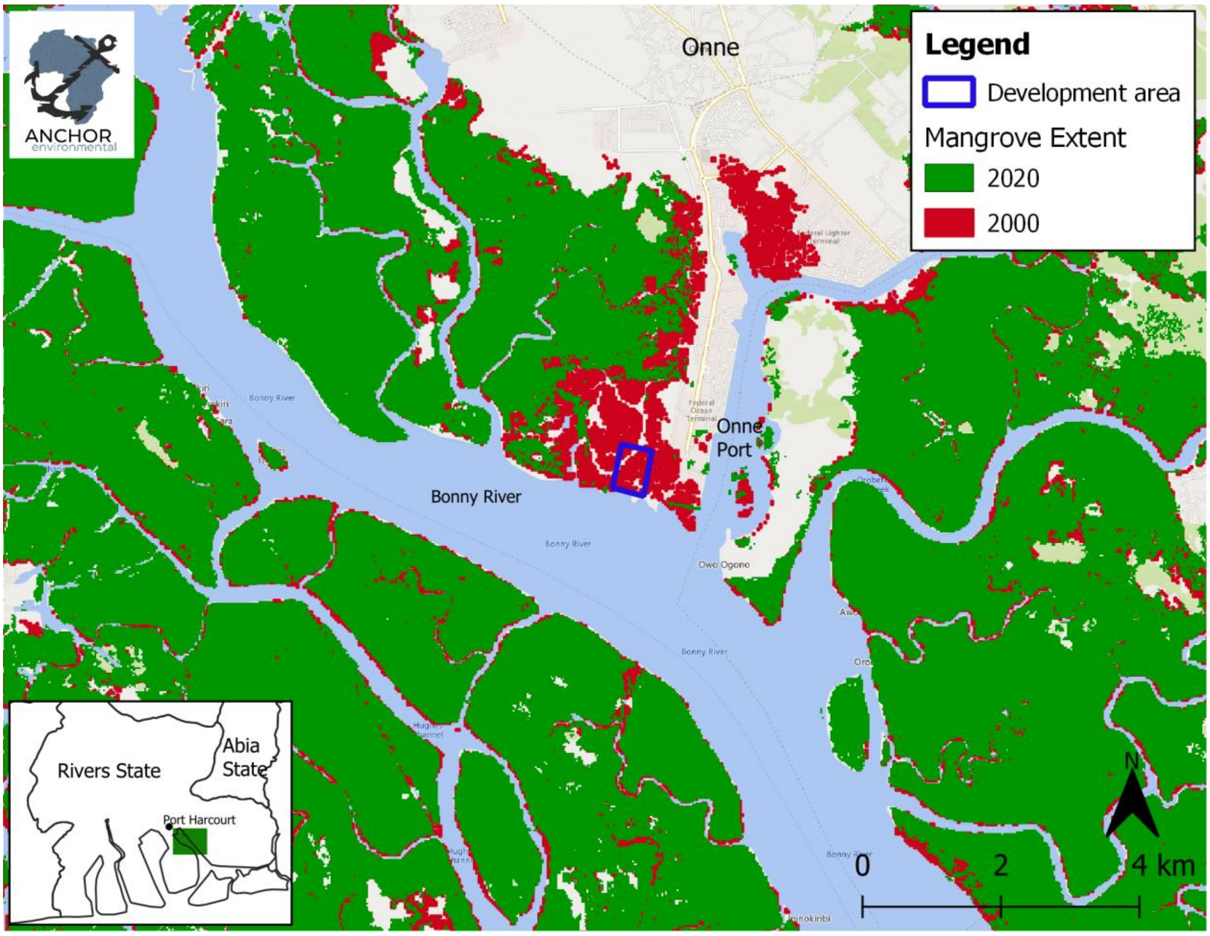


Figure 4-42: Changes in Mangrove Extent between 2000 (Giri et al. 2011) and 2020 (Global Mangrove Watch 2022) in the Area of Interest, based on Satellite Imagery.

Figure 4-43: Fringe of Mangrove and other vegetation along the Bonny River Estuary Water Ways.

4.5.3.5 Phytoplankton

Phytoplankton make up the basal component of aquatic food chains, with all other organisms depending on them for food, either indirectly or directly. Studying the phytoplankton of a system can provide insight into its productivity and the food availability for higher trophic levels such as fish. They can serve as a bioindicator of pollution in estuarine systems (Ajuonu et al. 2011).

Although the July 2023 baseline data collection study sampled a wider area and more sites for phytoplankton. The phytoplankton diversity and abundance were higher in the dry season. This was also observed in another study of the lower Bonny Estuary, and was attributed to increases in nutrients and salinity (Chindah and Braide 2004).

In the dry season (Table 4-26), four major algal groups were represented, namely Bacillariophyceae (diatoms; 58% relative abundance), Chlorophyceae (green algae; 31%), Cynaophyceae (bluegreen bacteria; 7%) and Pyrrophyceae (dinoflagellates; 4%), while in the wet season (Table 4-27) only Bacillariophyceae were present (Figure 4-44). As well as being the most abundant, diatoms also had the most genera. The dominance of diatoms has been observed in other studies of the Bonny Estuary (Chindah and Braide 2004, Ejiowhor et al. 2018, Daka et al. 2019b).

Table 4-27: Composition, Abundance and Community Indices of Phytoplankton for the Dry Season (January 2022).

TAXA	Dry Season Sampling Site				
	SW1	SW2	SW3	SW4	SWC1
BACILLARIOPHYCEAE					
Cymbella hydrida	10	14	11	8	10
Cymbella lacustris	8	12	16	10	4
Cymbella striate	14	8	11	13	12
Melosira various	11	13	10	8	14
Melosira distans	18	6	12	11	17
Tabellaria fenstrata	6	9	11	8	6
CHLOROPHYCEAE					
Netrium digitus	11	13	10	8	14
Micrasterias radiate	18	6	12	11	17
Micrasterias denticuata	6	9	11	8	6
PYRROPHYCEAE					
Peridinium cinatum	2	0	1	6	4
Ceratum hirudinella	0	0	2	4	3
CYANOPHYCEAE					
Anabaena sp.	8	5	7	8	6
Snewella rosea	3	0	3	0	1
No. of Genera (S)	12	10	13	12	13
Abundance (N)	115	95	117	103	114
Margalef Richness (d)	0.87	1.98	2.52	2.37	2.53
Pielou Evenness (J')	0.94	0.98	0.94	0.99	0.92
Shannon (H')	2.34	2.25	2.42	2.45	2.37
Simpson (λ)	0.11	0.11	0.09	0.09	0.11

Table 4-28: Composition, Abundance and Community Indices of Phytoplankton for the Wet Season (July 2023).

TAXA	SW1	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW 10	SW C1	SW C2
BACILLARIOPHYCEA												
Coscinodiscus sp	10	6	8	5	0	7	12	9	2	3	11	8
Cerataulina pelagica	0	0	0	0	0	0	0	0	0	2	0	0
Gyrosigma sp	7	3	59	17	20	5	2	0	14	4	1	4
Nitzschia sp	0	0	26	2	12	4	0	2	20	8	1	0
Synedra sp	1	3	32	7	22	4	2	0	11	5	4	2
No of Genera (S)	3	3	4	4	3	4	3	2	4	5	4	3
Abundance (N)	18	12	125	31	54	20	16	11	47	22	17	14
Margalef Richness (d)	0.69	0.80	0.62	0.87	0.50	1.00	0.72	0.42	0.78	1.29	1.06	0.76
Pielou Evenness (J')	0.78	0.95	0.87	0.82	0.97	0.98	0.67	0.68	0.86	0.93	0.69	0.87
Shannon-Weiner (H')	0.85	1.04	1.21	1.14	1.07	1.36	0.74	0.47	1.20	1.50	0.96	0.96
Simpson (λ)	0.46	0.38	0.34	0.38	0.35	0.27	0.59	0.70	0.33	0.24	0.48	0.43

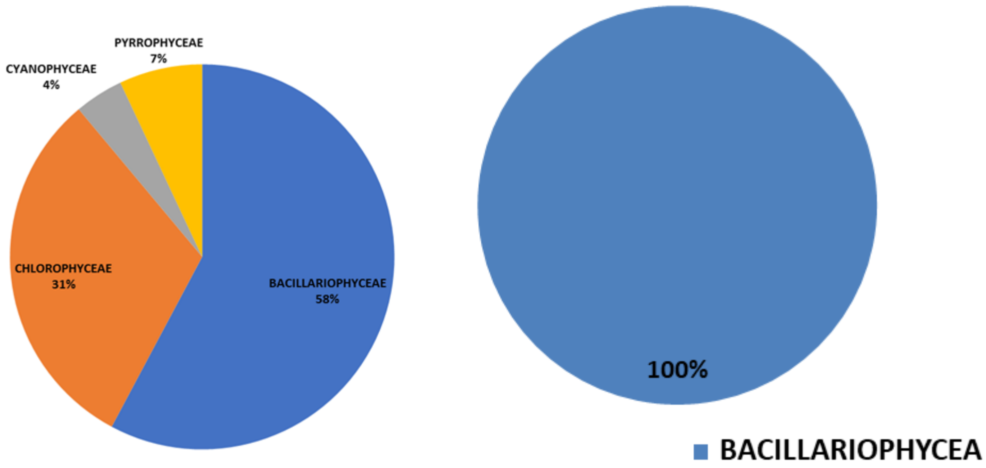


Figure 4-44: Relative Abundance of Phytoplankton Taxa for the Dry Season (left; January 2022) and Wet Season (right; July 2023).

4.5.3.6 *Zooplankton*

Zooplankton are closely linked to their aquatic environment and respond far more rapidly to environmental changes than larger organisms such as fish, making them valuable indicators of the quality and changes in aquatic environments. As they make up the basic food source for higher trophic levels, they are also useful indicators for future fisheries health, and as such, zooplankton biomass, abundance and diversity can be used to determine the condition of aquatic environments. Copepods tend to dominate the zooplankton community of most aquatic ecosystems (Davies and Ugwumba 2013b).

Zooplankton communities are sensitive to changes in season, tide, and associated changes in water quality, such as salinity and temperature, as well as the abundance of phytoplankton.

A study of the zooplankton community of the Upper Bonny Estuary conducted between 2004-2006 recorded 7 taxa, 66 genera and 85 species. Rotifera (29 species) and Copepoda (26 species) were the most diverse groups. The zooplankton density and species diversity is an indicator of the high nutrient levels present in the upper estuary (Davies and Ugwumba 2013b). The latter study observed that zooplankton densities and diversity was highly tide dependent, which was thought to be related to pollutant concentration or salinity (Davies and Ugwumba 2013b). Another study in the Bonny Estuary recorded fewer species, at just 31, and also found copepods to be dominant (Ajuonu et al. 2011). The zooplankton field surveys conducted for this study, recorded 28 species in total over both seasons, with slightly more species observed in the wet season, although as more sites were surveyed in the wet season, the seasonal data are not directly comparable. Species were largely different between seasons. The low species diversity recorded in comparison to other studies may be due to relatively low sampling effort; for instance the 66 genera from Davies and Ugwumba 2013b was from 24 monthly samples from eight stations.

In the samples collected in this study, the number of genera (13 dry season, and 16 wet season) and abundance (15-68 /ml dry season, 68 – 559 / ml wet season) were greater in the wet season than in the dry season (Table 4-28 and Table 4-29). In the dry season the zooplankton community was represented by five major taxa, namely, Copepoda (81% relative abundance), Cladocera (10%), Rotifera (5%), Ostracoda (1%) and Decapoda (3%) (Figure 4-45). While in the wet season just three major taxa were recorded; copepoda (98.16% relative abundance), decapoda (1.78%), and amphipoda (0.06%) (Figure 4-46). As observed in previous studies, copepods are generally dominant in the Bonny River Estuary (Daka et al. 2019a). The abundance of copepods and presence of many larvae, ranging from fish to arthropods, in the Bonny River Estuary, indicates that the system is an ideal fish nursery and breeding ground (Ajuonu et al. 2011).

Table 4-29: Composition, Abundance and Community Indices of zooplankton in the Dry Season Survey (January 2022).

Taxa	SW1	SW2	SW3	SW4	SWC1
COPEPODA					
Metridia lucens	5	2	8	4	11
Calamus finmarchicus	3	5	7	8	10
Acartia longiremis	0	1	4	7	9
Anomalocere patersoni	2	4	3	6	12
Pseudocalamus elongatus	0	2	4	8	14
CLADOCERA					
Peniclia arirosteris	0	0	0	2	1
Evadne nordmanni	0	1	0	1	3

Taxa	SW1	SW2	SW3	SW4	SWC1
Podonpolyphemides	1	0	0	3	4
ROTIFERA					
Rotaria citria	0	0	2	0	1
Rotaria rataria	2	1	0	2	1
DECAPOD CRUSTACEA					
Crab (larva)	0	0	2	0	1
Shrimp (larva)	2	1	0	2	1
OSTRACODA					
Conchocia spinirastris	0	0	0	2	0
No of Genera (S)	6	8	7	11	12
Abundance (N)	15	17	30	45	68
Margalef Richness (d)	1.85	2.47	1.76	2.63	2.61
Pielou Evenness (J')	0.94	0.9	0.94	0.92	0.84
Shannon-Weiner (H')	1.68	1.87	1.82	2.21	2.09
Simpson (λ)	0.21	0.18	0.18	0.13	0.15

Table 4-30: Composition, Abundance and Community Indices of Zooplankton in the Wet Season Survey (July 2023).

Taxa	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8	SW 9	SW 10	SWC 1	SWC 2
COPEPODA												
Nauplius	87	92	10	13	81	76	117	102	0	12	59	31
Acartia tonsa	0	2	0	0	0	0	0	1	0	0	0	0
Calanus finmarchicus	44	53	0	0	58	42	82	56	0	0	32	18
Pseudocalanus newmani	73	80	0	24	39	66	79	81	19	30	37	22
Paracalanus parvus	67	32	28	5	77	63	80	67	18	4	46	37
Parvocalanus sp.	11	4	0	0	4	9	17	9	0	0	7	9
Temora sp.	0	0	3	0	24	3	0	0	0	0	2	0
Tortanus sp.	43	27	20	0	55	49	76	44	14	20	51	19
Oithona sp.	71	52	15	13	61	34	89	72	22	0	46	44
Halicyclops fosteri	0	0	0	0	0	0	0	0	0	2	0	0
Corycaeus sp.	0	0	0	0	18	7	0	12	0	0	0	0
Euterpina sp.	0	0	16	0	7	0	0	7	0	0	0	0
DECAPODA												
Brachyuran crab zoea	4	0	0	0	0	12	17	7	0	0	3	0

Taxa	SW 1	SW 2	SW 3	SW 4	SW 5	SW 6	SW 7	SW 8	SW 9	SW 10	SWC 1	SWC 2
Scyllarus sp.	0	0	0	2	0	0	0	0	0	0	2	0
Alpheaus sp.	0	0	12	0	0	0	0	0	0	0	0	0
AMPHIPODA												
Gammarus sp.	0	0	0	0	0	0	2	0	0	0	0	0
No of Genera (S)	8	8	7	5	10	10	9	11	4	5	10	7
Abundance (N)	400	342	104	57	424	361	559	458	73	68	285	180
Margalef Richness (d)	1.17	1.20	1.29	0.99	1.49	1.53	1.26	1.63	0.70	0.95	1.59	1.16
Pielou Evenness (J')	0.90	0.85	0.93	0.85	0.90	0.87	0.89	0.84	0.99	0.81	0.84	0.95
Shannon-Weiner (H')	1.88	1.77	1.81	1.37	2.07	2.01	1.96	2.01	1.37	1.30	1.94	1.85
Simpson (λ)	0.16	0.19	0.18	0.29	0.14	0.15	0.15	0.15	0.26	0.32	0.16	0.17

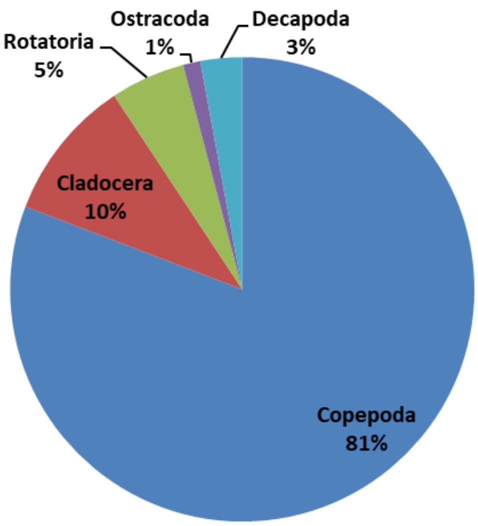


Figure 4-45: Relative Abundance of Zooplankton Taxa (Dry Season, January 2022).

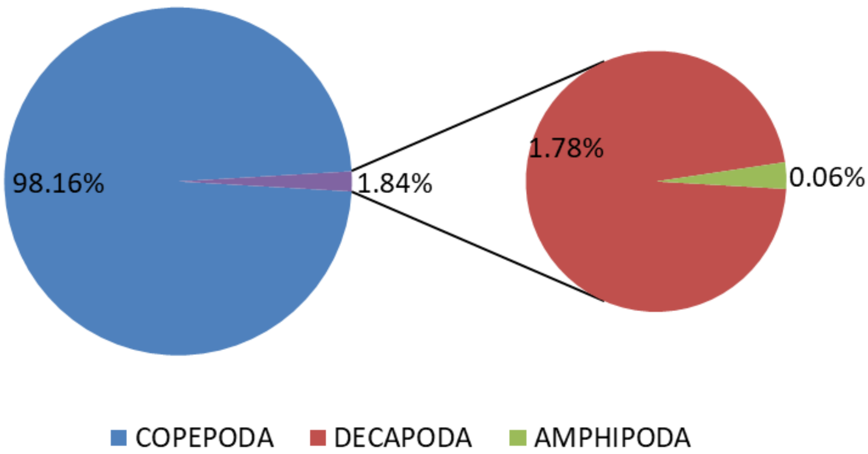


Figure 4-46: Relative Abundance of Zooplankton Taxa (Wet Season – July 2023).

4.5.3.7 Benthic Macrofauna

The use of benthic macrofauna in aquatic ecological research, and particularly in evaluating the impacts of large-scale environmental perturbations, both natural and anthropogenic, is a globally utilised, highly effective monitoring tool. These faunas are largely dependent on local environmental conditions for their survival and reproduction, and changes in these conditions (through, for example, the discharge of thermally elevated water and pollution) can cause shifts in community structure. Benthic macrofaunal indicators, such as species abundance, biomass, and diversity, provide a direct measure of the state of the ecosystem in space and time. Benthic macrofauna are the biotic component most frequently monitored to detect changes in the health of a marine/estuarine environment as they are relatively non-mobile, short lived and their community composition responds rapidly to environmental change. They also tend to be directly affected by pollution, are easy to sample quantitatively, and are scientifically well-studied compared to other sediment-dwelling components. The benthic biota of marine substrates typically constitutes invertebrates that live on (epifauna), or burrow within (infauna), the sediments, and are generally divided into megafauna (animals >10mm), macrofauna (>1mm) and meiofauna (<1mm).

The macrofaunal community composition in Niger Delta estuaries is generally typical of the shallow water mud/muddy-sand habitats of the West African Atlantic coast, and contains several species that characterise the tropical mangrove muddy-sand association (Ewa-Oboho et al. 2005).

From the samples collected in this study, six benthic macrofauna taxa were recorded during the dry season survey, and 15 taxa during the wet season survey. This is a relatively low diversity compared to other studies in the Niger Delta: surveys reported 19 species from the Okpoka creek (one of the several adjoining creeks off the Upper Bonny River estuary, see George et al. 2009), 28 species from the Sombreiro River (Ezekiel et al. 2011), and 33 taxa from the Woji Creek in the upper reaches of Bonny River (Hart and Zabbey 2005). A survey of Bodo Creek reported 22 species of benthic macrofauna in July 2006 and 18 species in July 2007 (Zabbey and Uyi 2014). The diversity is also low compared to other West African systems — surveys in the Sherbro River estuary in Sierra Leone reported 25 and 20 taxa in the dry and wet seasons respectively, and 24 families were recorded in the dry season in the Rio Nunez estuary in Guinea (Bovim et al. 2023, Clark et al. 2023).

The 2022 and 2023 macrofauna field surveys recorded just two phyla (annelida and mollusca) in the dry season, while six phyla were recorded in the wet season Table 4-3031 and Table 4-3132), bearing in mind that many more sites and a wider area was sampled in the wet season. In the dry season, the class polychaeta dominated with four genera and a relative abundance of 96% (Figure 4-477). In the wet season, polychaetes also dominated, but to a lesser degree, accounting for 50% of the relative abundance (Figure 4-48). Crustaceans contributed 23% of relative abundance, while the other taxa were oligochaeta (16%), insecta (7%), mollusca (3%), and pisces (fish; 1%). Four of the wet season sampling sites did not have any macrofauna (SW5, SW7, SW9-10) (Figure 4-488).

Table 4-31: Composition, Abundance and Community Indices of Benthic Fauna (Dry Season, January 2022).

TAXA	SW1	SW2	SW3	SW4	SWC1
POLYCHAETA					
Nereis diversicolar	5	7	11	10	14
Neathes sp	3	5	4	8	11
Martphysa sp	0	0	2	4	6
Notomastus sp	0	0	0	2	2
MOLLUSCA					
Tellina sp.	0	0	1	0	2
Melampus sp.	0	0	0	1	0
No of Genera (S)	3	3	5	6	6
Abundance (N)	16	24	35	49	68
Margalef Richness (d)	0.72	0.63	1.13	1.29	1.19
Pielou Evenness (J')	0.93	0.94	0.76	0.77	0.78
Shannon-Weiner (H')	1.02	1.03	1.23	1.38	1.39
Simpson (λ)	0.38	0.38	0.35	0.32	0.31

Table 4-32: Composition, Abundance and Community Indices of Benthic Fauna (Wet Season – July 2023).

TAXA	SWI	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10	SWC1	SWC2
POLYCHAETA												
Cossura spp	0	15	0	8	0	1	0	0	0	0	0	3
Cirriformia spp	0	3	0	0	0	0	0	0	0	0	0	1
Eunice spp	0	0	4	0	0	0	0	5	0	0	1	1
Glycera spp	0	1	1	4	0	0	0	1	0	0	1	1
Nephtys spp	7	0	0	0	0	0	0	0	0	0	0	1
Nereis spp	0	0	0	0	0	0	0	0	0	0	0	3
Polydora spp	0	0	0	0	0	0	0	0	0	0	0	1
Arenicola sp	0	1	0	0	0	0	0	0	0	0	0	0
OLIGOCHAETA												
Naididae	0	1	0	9	0	1	0	4	0	0	0	5
Lumbriculidae	0	1	0	0	0	0	0	0	0	0	0	0
INSECTA												
Chironomid larva	1	1	2	5	0	0	0	0	0	0	0	0
MOLLUSCA												

TAXA	SWI	SW2	SW3	SW4	SW5	SW6	SW7	SW8	SW9	SW10	SWC1	SWC2
Buccinum (Gastropod)	0	0	0	2	0	0	0	0	0	0	0	0
Bivalve	0	0	0	2	0	0	0	0	0	0	0	0
CRUSTACEA												
Cumacean	7	7	0	4	0	1	0	0	0	0	0	0
Talitri spp	0	4	0	5	0	1	0	1	0	0	0	0
PISCES												
Fish	1	0	0	0	0	0	0	0	0	0	0	0
No of Genera (S)	4	9	3	8	0	4	0	4	0	0	2	8
Abundance (N)	16	34	7	39	0	4	0	11	0	0	2	16
Margalef Richness (d)	1.08	2.27	1.03	1.91		2.16		1.25			1.44	2.52
Pielou Evenness (J')	0.77	0.76	0.87	0.94		1.00		0.84			1.00	0.89
Shannon-Weiner (H')	1.07	1.67	0.96	1.96		1.39		1.16			0.69	1.86
Simpson (λ)	0.39	0.26	0.43	0.15		0.25		0.36			0.50	0.19

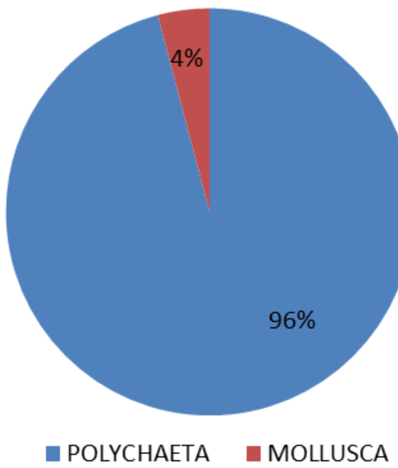


Figure 4-47: Relative Abundance of Taxa in the Benthos (Dry Season, January 2022).

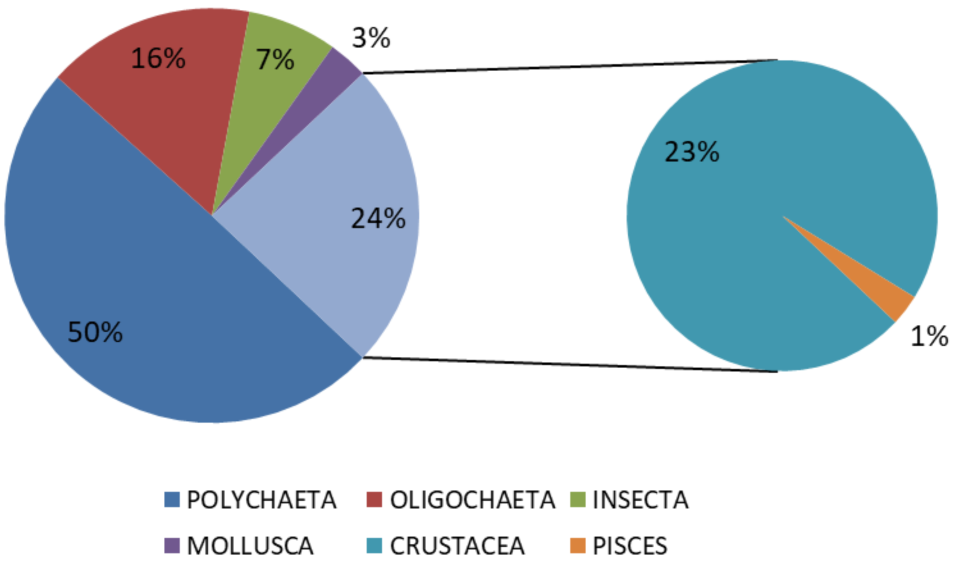


Figure 4-48: Relative Abundance of Taxa in the Benthos (Wet Season – July 2023).

The overall low diversity of benthic macrofauna seen in the 2022 and 2023 sampling surveys of the Bonny Estuary has been attributed to dredging, of which a significant amount has occurred within the system.

Dredging of the sea or riverbed is performed worldwide in order to expand and deepen existing harbours/ports or to maintain navigation channels and harbour entrances (Erftemeijer and Robin Lewis 2006) and has therefore been touted as one of the most common anthropogenic disturbance of marine and estuarine environments (Bonvicini Pagliai et al. 1985). The potential impacts of dredging on the environment can stem from both the removal of substratum from the seafloor/river bottom and the disposal of dredged sediments, and include:

- Direct destruction of benthic fauna populations due to substrate removal;
- Burial of organisms due to disposal of dredged sediments;
- Alterations in sediment composition which changes nature and diversity of benthic communities (e.g., decline in species density, abundance and biomass);
- Enhanced sedimentation;
- Changes in bathymetry which alters current velocities and wave action; and
- Increase in concentration of suspended matter and turbidity due to suspension of sediments. The re-suspension of sediments may give rise to:
  - Decrease in water transparency;
  - Release in nutrients and hence eutrophication;
  - Release of toxic metals and hydrocarbons due to changes in physical/chemical equilibria;

- Decrease in oxygen concentrations in the water column;
- Bioaccumulation of toxic pollutants;
- Transport of fine sediments to adjacent areas, and hence transport of pollutants; and
- Decreased primary production due to decreased light penetration to water column.

Aside from dredging itself, dredged material may be suspended during transport to the surface, overflow from barges or leaking pipelines, during transport to dump sites and during disposal of dredged material (Jensen & Mogensen, 2000 in Erftemeijer & Robin Lewis, 2006).

The quantity and distribution of different sediment grain particle sizes (sand, silt and clay) influences the status of biological communities and the extent of organic loading that may occur. As seen in Section 0, sediment particle size distribution was generally very similar across all sites. However, in the wet season survey there was no clear relationship between sediment characteristics and macrofaunal abundance (Figure 4-49). This suggests that other factors act as more significant drivers of macrofaunal abundance.

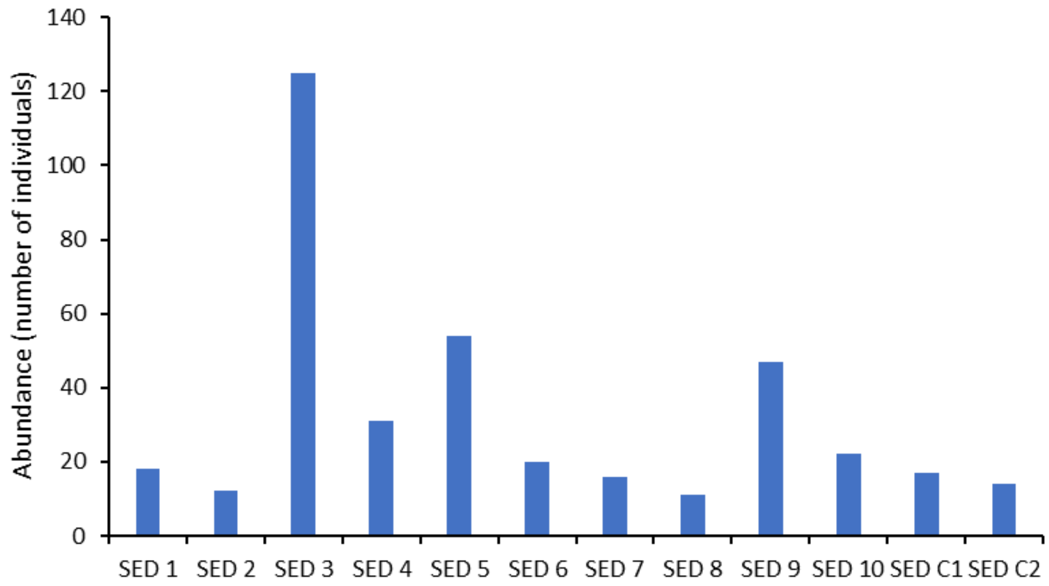


Figure 4-49: Percentage Sediment Composition and Percentage Total Organic Carbon (TOC) (top) and Macrofaunal Abundance (bottom) per Site in the Wet Season Survey

4.5.3.8 Fish

A total of 20 fish species from 15 families were sampled across both seasons (Table 4-32,

Table 4-33), which is substantially lower diversity than has been recorded in other West African estuaries. For example, 71 species were recorded in the Sherbro River Estuary (Sierra Leone), 67 species in the Gambia Estuary (Gambia), 73 species in the Sine Saloum Estuary (Senegal), and 64 species in the Ebrié Lagoon (Ivory Coast) (Simier et al. 2004, 2006, Écoutin et al. 2005, Clark et al. 2023). Some 173 fish species occurring in western and central African estuaries have been recorded, based on data contained within ten different studies undertaken in at least five different West African countries (Nigeria, Guinea, Senegal, Ivory Coast, Benin) (Whitfield 2005). However, comparisons with the fish diversity of more local estuaries indicates that in general, Nigerian estuaries within and near the Niger Delta have lower fish diversity than recorded in the other West African systems, with diversity ranging from 53 species in the Brass and Nun rivers, 34 species in the Forcados River Estuary, 33 species in the Bonny Estuary (Ekeke et al. 2008), 26 in New Calabar River (Dienye et al. 2018) and down to 17 species in the Qua Iboe River Estuary (Ekpo et al. 2014, Oguntade et al. 2014, Efe and Bemigho 2021) and 11 in Okpoka creek, and upper Bonny estuary (Davies 2009). This lower diversity is likely linked to overfishing, dredging, and oil spills in the region (Davies 2009, Oguntade et al. 2014, Osuagwu and Olaifa 2018). However, the fish diversity observed in this study is lower than some of these other studies, which may be due to differences in sampling effort or sampling methods. Notably, Ekeke et al. 2008 with 33 species in Bonny estuary (compared to 20 species in this study) was collected from landings from five fishing boats (using different gear) over a period of 12 days in 2 months.

Seasonality was evident in the fish survey results, with five more species captured in the wet season than in the dry season, which is likely to be due to greater sampling effort in the wet season (Table 4-32, Table 4-43). Five species were present in both seasons' surveys. Seasonal changes in abundance were observed, such as for Bagrid catfish *Chrysichthys nigrodigitatus* which was common in the dry season but rare in the wet season. Only one predominantly freshwater species was sampled, the nurse tetra *Brycinus nurse*, which was present but rare in the wet season samples.

Of the species sampled, all were "Not Evaluated" by CITES, and most were classified as Least Concern on the IUCN Red List for Endangered Species (IUCN 2022). Madeiran sardinella *Sardinella maderensis* (IUCN Vulnerable due to overexploitation and population decline) were abundant in the dry season and common in the wet season (Table 4-32), while white grouper *Epinephelus aeneus* (IUCN Near Threatened) were only present in the wet season but common (**Table 4-33**).

Table 4-33: Composition of Fish Reported during the Dry Season Survey (January 2022).

Family	Scientific name	Common Name	Local (Okrika) Name	Abundance Score	IUCN Red List Status (IUCN 2022)
Clupeidae	*Ethmalosa fimbriata*	Bonga shad	Kigbo	Dominant	LC
	Sardinella maderensis	Madeiran sardinella	Songu	Abundant	VU
Sciaenidae	*Pseudotolithus enlongatus*	Bobo croaker	Ona	Abundant	LC
	Pseudotolithus epipercus	Guinea croaker	Ona	Common	LC
Mugilidae	*Mugil cephalus*	Flathead grey mullet	Beme	Common	LC
Bagridae	*Chrysichthys nigrodigitatus*	Bagrid catfish	Aga	Common	LC

Family	Scientific name	Common Name	Local (Okrika) Name	Abundance Score	IUCN Red List Status (IUCN 2022)
Lutjanidae	*Lutjanus goreensis*	Gorean snapper	Agbara	Common	LC
Haemulidae	*Pomadasys jubelini*	Spotted grunt	Owolo	Common	LC
Cichlidae	*Sarotherodon melanotheron*	Blackchin tilapia	Omoda	Abundant	LC
Gobiidae	*Porogobius schlegelii*	Goby	Ikinji	Rare	LC

Table 4-34: Composition of Fish Observed during the Wet Season Survey (July 2023).

Family	Scientific name	Common Name	Local (Okrika) Name	Abundance Score	IUCN Red List Status (IUCN 2022)
Cichlidae	*Sarotherodon melanotheron*	Blackchin tilapia	Omoda	Abundant	LC
	Coptodon guineensis	Guinean tilapia	Atabala	Abundant	LC
Haemulidae	*Pomadasys jubelini*	Sompat grunt	Owolo	Abundant	LC
	Plectorhinchus macrolepis	Biglip grunt	Olokpo	Common	LC
Mugilidae	*Mugil cephalus*	Flathead grey mullet	Beme	Common	LC
	Neochelon falcipinnis	Sicklefin mullet	Gbulu	Common	DD
Lutjanidae	*Lutjanus agennes*	African red snapper	Agbara	Common	DD
Clupeidae	*Sardinella maderensis*	Madeiran sardinella	Songu	Common	VU
	Sardinella aurita	Round sardinella	Asara	Dominant	LC
Serranidae	*Epinephelus aeneus*	White grouper	Orom	Common	NT
Gerreidae	*Eucinostomus melanopterus*	Flagfin mojarra	Otubulu	Rare	LC
Carangidae	*Caranx hippos*	Crevalle jack	Okwe	Common	LC
Claroteidae	*Chrysichthys nigrodigitatus*	Bagrid catfish	Aga	Rare	LC
Alestidae	*Brycinus nurse*	Nurse tetra	Ogein	Rare	LC
Tetraodontidae	*Sphoeroides pachygaster*	Blunthead puffer	Ibupu	Rare	LC

A ***Ethmalosa fimbriata***

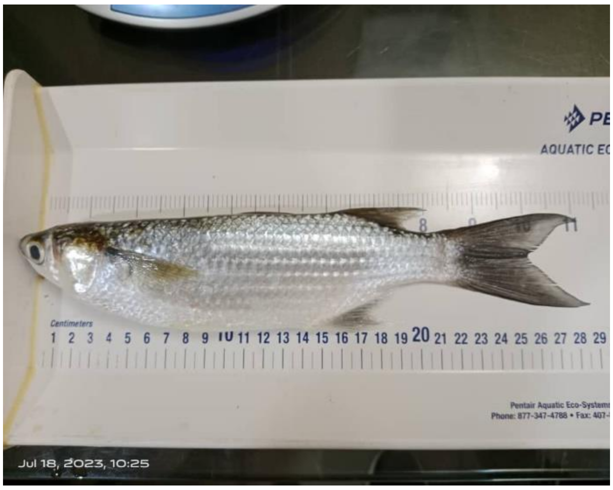
B ***Pseudotolithus epipercus***

C: ***Coptodon guineensis***

D ***Sarotherodon melanotheron***

E ***Pomadasys jubelini***

F ***Plectorhinchus macrolepis***



G: ***Mugil cephalus***

H: ***Neochelon falcipinnis***

I: ***Eucinostomus melanopterus***

J: ***Lutjanus agennes***

K: ***Sardinella maderensis***

L: ***Sardinella aurita***

Plate 4-1: Pictorial evidence of some fish composition during wet season

Salinity is a major driver influencing fish communities including aspects such as composition, abundance and distribution in African estuaries (Whitfield, 2005). Turbidity and temperature are also considered important factors structuring tropical estuarine fish communities (Simier et al., 2006; Écoutin et al., 2010). However, these variables are nearly always correlated with the increased freshwater flows associated with the rainy season which typically results in decreased salinity and increased turbidity, whilst reduced river flow and increased marine influence via tidal flows during the dry season have the opposite effect, making it difficult to identify the most dominant drivers. These seasonal variations associated with wet and dry periods in tropical regions bring about substantial ecological changes in the estuarine biota. Many estuarine species seasonally shift their distributions up or downstream to suit their salinity tolerances, whilst increased flushing and light attenuation due to floods, results in decreased primary productivity and repercussions throughout the food web. Fish being highly mobile, and secondary or tertiary consumers, show a marked response to seasonal variations in estuaries. Most freshwater fish species can only colonise estuaries when low salinities (oligohaline) conditions exist, whilst conversely some marine fish species are stenohaline and can only occupy the lower reaches of estuaries during low flow periods (Whitfield, 2005). Some marine estuarine and all fully estuarine species, are euryhaline and can occupy estuaries most of the time, thus forming the core of the estuarine fish community, but even these species may shift their distributions with seasonal events such as floods (Whitfield, 2005). More fish are usually landed in the dry season of Nigerian estuaries, with the increase mainly attributed to an influx of marine species associated with increased salinity (Amadi 1990). This pattern was not observed during the field sampling, most likely due to low sampling effort.

Estuaries such as the Bonny River Estuary, and particularly those fringed with mangrove, serve as nursery habitats for juvenile fish, due to their sheltered conditions, food availability, and protection from marine predators (Whitfield 2020, Guerreiro et al. 2021). All species sampled in the study area are known to have some level of estuarine affinity, with nine species with varying dependency on estuaries for breeding, for example black-chin tilapia *Sarotherodon melanotheron*, Bonga shad *Ethmalosa fimbriata*, and biglip grunt *Plectorhinchus macrolepis.* The health of estuaries is particularly important for the breeding success of these species, and therefore also their abundance in fisheries.

4.5.3.9 Avifauna

Waterbirds (i.e., those that have a close association with water for feeding, roosting or nesting purposes; seabirds and waders, etc.) are excellent indicators on the health and status of estuarine habitats, especially the long-term changes in the health of their environment, due to most birds' longevity (6-15 years+) (Piatt et al. 2007). They occupy high trophic levels, and their populations respond rapidly to declines in habitat quality, food supply (e.g., fish and intertidal invertebrates), or disturbance due to human presence or infrastructural development. They are highly visible and congregate at feeding and breeding locations facilitating enumeration of multiple species simultaneously (Piatt et al. 2007).

The large majority of species observed are associated with estuarine systems of West Africa and are considered migratory (Schneider 1983). Coastal mangrove and exposed sandflat areas offer important habitats for these species. Species such as sandpipers, plovers, and avocets feed on invertebrates and small crustaceans found along the shoreline (Schneider 1983).

West Africa plays a crucial role in supporting and providing habitat for migrating waterbirds. The region serves as a key stopover site along the 'East Atlantic Flyway', which is a major migratory route for birds traveling between their breeding grounds in Europe and their wintering grounds in West Africa (van Roomen et al. 2020). West Africa is also home to a diverse range of wetland habitats, including estuaries, coastal lagoons, mangroves, rivers, and inland wetlands. These habitats provide essential feeding and resting areas for migrating waterbirds during their long journeys (van Roomen et al. 2020).

Of the waterbird species which inhabit the study region, 14 species are listed as either Critically Endangered (CR), Endangered (EN), Vulnerable (VU) or Near Threatened (NT) on the IUCN Red List (Table 4-34) (IUCN 2022), meaning that conservation of the habitats such as mangroves and mudflats which support these species is important. The waterbird surveys were based on the interview with the locals and the opportunistic / on the spot assessment.

Table 4-35: Endangered Waterbird Species that May Occur on the Bonny River Estuary (IUCN 2022, BirdLife International 2023).

Family	Scientific name	English name	Global IUCN Red List Category (IUCN 2022)
Anatidae	*Aythya ferina*	Common Pochard	VU
	Aythya nyroca	Ferruginous Duck	NT
	Marmaronetta angustirostris	Marbled Teal	NT
Glareolidae	*Glareola nordmanni*	Black-winged Pratincole	NT
Gruidae	*Balearica pavonina*	Black Crowned Crane	VU
Phoenicopteridae	*Phoeniconaias minor*	Lesser flamingo	NT
Haematopodidae	*Haematopus ostralegus*	Eurasian Oystercatcher	NT
Scolopacidae	*Calidris canutus*	Red Knot	NT
	Calidris ferruginea	Curlew Sandpiper	NT
	Gallinago media	Great Snipe	NT
	Limosa lapponica	Bar-tailed Godwit	NT
	Limosa limosa	Black-tailed Godwit	NT
	Numenius arquata	Eurasian Curlew	NT
Sulidae	*Morus capensis*	Cape gannet	EN

4.5.3.10 Reptiles and Mammals

A study of the reptiles of Bonny Island, an island just south of the Project site at the mouth of the Bonny River estuary, found semi-aquatic reptile species including the dwarf crocodile *Osteolaemus tetraspis* (IUCN Vulnerable), Nile crocodile *Crocodylus niloticus* (IUCN Vulnerable) and ornate Nile monitor *Varanus ornatus*, suggesting that these species may also be found further upstream (Akani and Luiselli 2010). The slender-snouted crocodile *Mecistops cataphractus* (IUCN Critically Endangered) may also occur in the area (IUCN 2022).

Turtles may also occur in the estuary, including the Endangered green turtle *Chelonia mydas* and Vulnerable leatherback *Dermochelys coriacea*, olive ridley *Lepidochelys olivacea*, and African softshell *Trionyx triunguis* turtles (IUCN 2022).

Aquatic mammals which may occur in the Bonny River estuary include the Critically Endangered Atlantic humpback dolphin (*Souza teuszii*), Vulnerable African manatee (*Trichechus senegalensis*) and hippopotamus (*Hippopotamus amphibius*), and Near Threatened otters the African clawless otter (*Aonyx capensis*) and spotted-necked otter (*Hydrictis maculicollis*) (IUCN 2022).

4.5.3.11 Endangered Species

The IUCN Red List indicates the presence of 14 Endangered, Threatened or Protected (ETP) waterbird species , 21 fish species (**Table 4-35**)), five mammal species, and at least five reptile species that may be encountered in estuarine systems in Nigeria, and which have the potential to be present in the Bonny River Estuary (when considering the Critically Endangered, Endangered, Vulnerable, and Near Threatened IUCN categories; IUCN 2022). Amongst the sharks and rays, 138 species that are found in Nigerian coastal waters are ETP species, and it is likely that many of these may venture into estuaries such as the Bonny River (IUCN 2022).

Table 4-36: Endangered Fish Species that May Occur in the Bonny River Estuary (IUCN 2022).

Family	Scientific Name	Common name	Global IUCN Red List Category (IUCN 2022)
Claroteidae	*Notoglanidium akiri*	Catfish species	EN
	Sardinella maderensis	Maderian sardinella	VU
Cynoglossidae	*Cynoglossus canariensis*	Canary tonguesole	NT
	Cynoglossus monodi	Guinean tonguesole	NT
	Cynoglossus senegalensis	Senegalese songuesole	NT
Epinephelidae	*Epinephelus aeneus*	White grouper	NT
	Epinephelus itajara	Atlantic goliath grouper	VU
	Mycteroperca goreensis	Dungat grouper	NT
	Mycteroperca marginatus	Dusky grouper	VU
Gobiidae	*Bathygobius burtoni*	Goby species	EN
	Corcyrogobius lubbocki	Goby species	VU
	Didogobius amicuscaridis	Goby species	VU
Haemulidae	*Brachydeuterus auritus*	Bigeye grunt	NT
Megalopidae	*Megalops atlanticus*	Tarpon	VU
Polynemidae	*Galeoides decadactylus*	Lesser African threadfin	NT
	Pentanemus quinquarius	Royal threadfin	VU

Family	Scientific Name	Common name	Global IUCN Red List Category (IUCN 2022)
Sciaenidae	*Pentheroscion mbizi*	Blackmouth croaker	NT
	Pseudotolithus senegalensis	Cassava croaker	EN
	Pseudotolithus senegallus	Law croaker	VU
Sparidae	*Dentex angolensis*	Angola dentex	NT
Syngnathidae	*Hippocampus algiricus*	West African seahorse	VU

4.5.4 Ecosystem Services

The value and uses – hence ecosystem services of flora and fauna diversity in the area as reported by the indigenous peoples and residents of the area ranged from economic, social, cultural, and environmental/provisioning to health. More specifically, local natural resources were utilised or valued for food, medicine, timber, fuelwood and energy, ornamentals, gums, protection of streams and water bodies and soil erosion prevention.

Fauna was mainly seen as source of protein (meat/fish) and income, but also animals hide and skin for cultural activities, feathers, medicine, dispersion of seeds, spores, buds and stems for further regeneration, pollination, and cultivation of plants. Beyond the socioeconomic and cultural gains of biodiversity, the ecosystem services extend to regulating hydrological cycles regime, local and ambient air quality, carbon sequestration, recreation, and environmental aesthetics.

The ecosystem of the proposed Project itself is highly modified and thus mostly reduced to insignificant levels, and thus not further analysed or prioritized. However, the direct and indirect ecosystem services offered by the biodiversity in the area as enumerated and ascertained by the locals is listed in Table 4-36 below.

Table 4-37: High-level Summary of Ecosystem Services Related to Terrestrial Biodiversity in Proximity but Outside the Project site.

Flora	Mammals and Herpetofauna	Birds	Molluscs	Insects
Herbs for medicine	Meat	Production of feathers	Source of food for man and animals	Pollination (Figure 4-50)
Gums	Fats and oil for medicine	Pest control	Sources of protein	Plant seed dispersion
Timber	Cultural affiliation and belief systems (dances, totem, masquerades, rhymes, and rhythms)	Pollination	Income and revenue	Production of honey

Flora	Mammals and Herpetofauna	Birds	Molluscs	Insects
Organic matter	Hide and skin	Seed dispersion	Substrates for animal feed production	Food and source of protein
Regulation of local climate	Pets	Meat and food	Used for decoration	Environmental indicators
Regulation of hydrological cycle	Soil forming factors and processes	Planters of trees and fruits	Soil forming factors and processes	Soil forming factors and processes
Soil aeration and moisturization	Addition of nutrients to the soil	Cultural attachments and indication of progress via continuous nesting	Soil aeration and moisturization	Decomposers and detritus's feeders
Fruits, nuts, seeds, and snacks	Guardian spirits	Production of eggs and source of protein	Detritus feeders and decomposers	Pest and weed control
Edible leaves and vegetables	Pollination	Nutrient recycling	Landscaping and aesthetics	Maintenance of wildlife species
Spices	Seed dispersal	Provision of organic matter	Medicine	Provides food for other organisms especially birds and insect eating animals
Shelter for wildlife	Pest and weed control	Environmental beauty	Provision of shelter and protection for other insects against predators	Nutrient cycling
Recreation and leisure		Community timekeepers and regulators	Shells used for jewellery and ornaments	
Watershed protection		Natural town criers/informants		
Materials for cultural artifacts		Pets and partners		
Environmental aesthetics and beautification		Ecosystem indicators/restorers		

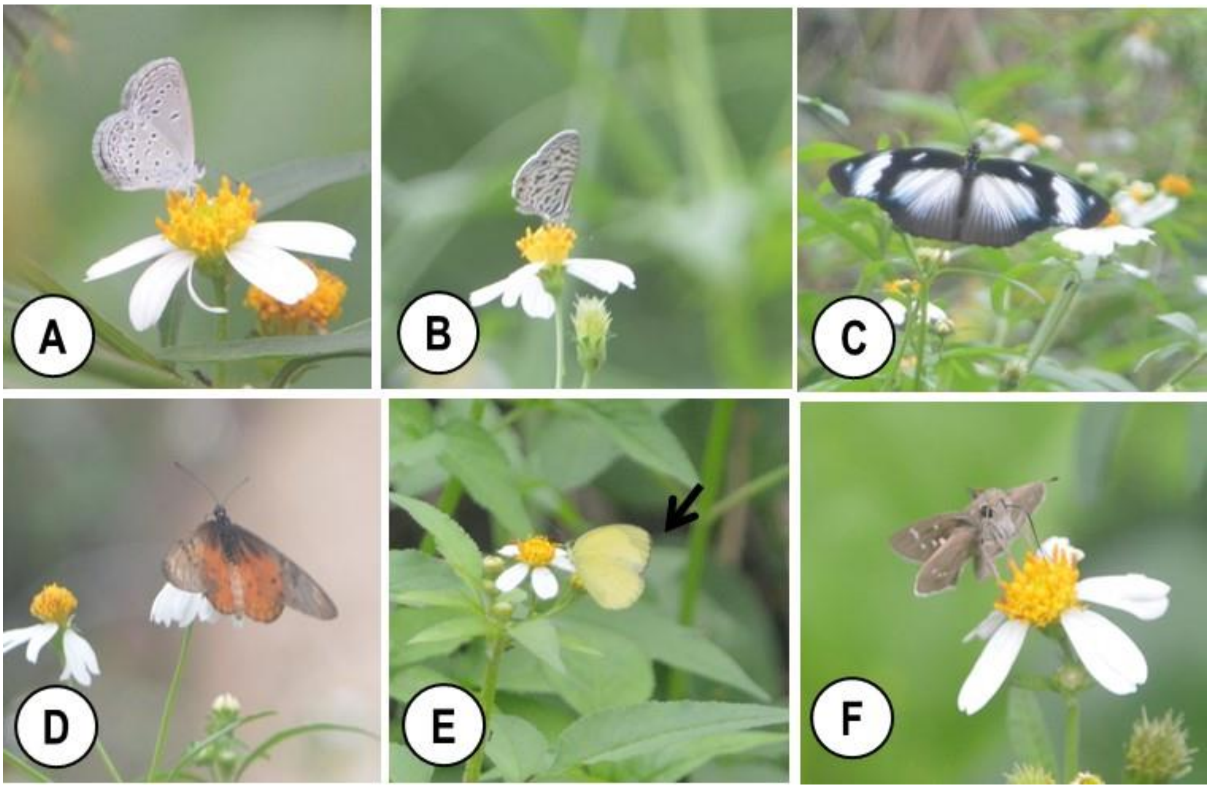


Figure 4-50: Some Insect Pollinators Observed in the Study Area.

From an aquatic perspective, all aquatic biota provides a range of ecosystem services. The most important of these services can be summarised as follows:

Mangroves, especially when in the form of natural forests, provide a range of ecosystem services. They are extremely productive systems, rich in biodiversity, provide important lifelong habitat and nursery grounds for a range of fish, invertebrates, birds, mammals and reptiles, refuge from predation as well as serving as a critical component of commercial coastal and offshore fisheries. Mangroves stabilize and trap nutrient-rich sediment transported down from river systems, protect shorelines from erosion, serve as a buffer during storm and high wind events, maintain water quality and clarity by way of a natural filtration system and are a significant carbon sink. Mangrove forests are one of the most productive ecosystems in terms of carbon cycling and storage (Jennerjahn and Ittekkot 2002). However, the rapid growth of human populations and the resulting pressure on coastal environments often lead to uncontrolled exploitation- of which timber and firewood are key resources harvested, posing severe threats to these ecosystems.

Aquatic herbs growing within or near water provide shelter, nesting sites and food for other aquatic organisms, including fish. they help to maintain water and sediment nutrient levels, accumulate toxins and other pollutants and as such remove them from water, whilst also contributing significantly to carbon storage.

Phytoplankton, Zooplankton and Benthic Macrofauna make up the lower end of the food chain for other aquatic organisms, most importantly fish and molluscs widely used as food by local communities. An indirect service is their ability to serve as indicators on the health of aquatic ecosystems and fisheries stability due to their rapid response in abundance and composition of species to system permutations.

Fish are widely consumed in the Area of Influence, providing an accessible source of protein in an area not extensively suitable for livestock production. Additionally, fish contribute significantly to controlling insects that may be carriers of diseases such as malaria.

4.5.5 Summary of Key Ecological Sensitivities

No Critical terrestrial Habitat triggering species were observed on the site or within the close area of influence. The following potential critical aquatic habitat triggering species terrestrial biodiversity sensitivities in proximiy to the site are anticipated:

Aquatic Birds: the water bird survey conducted during January 2024 does not confirm presence of threatened and/or migratory or congregatory waterbird species. However, given the availability of intertidal mudflat habitat within the Project development site, which lies within the range of such species, it is feasible that the site would support species such as common pochard *Aythya ferina* (VU), black crowned crane *Balearica pavonina* (VU), Eurasian curlew *Numeniu arquata* (NT), bar-tailed godwit *Limosa lapponica* (NT), & curlew sandpiper *Calidris ferruginea* (NT) which may qualify for Critical Habitat criteria 4 or 1.

Terrestrial Birds: African Grey Parrot (Psittacus erithacus, EN) and Knobbed Hornbill (Rhyticeros cassidix, VU) were observed flying over the Project site, but no habitat or resource for such within the Project site.

Fish: The following species were recorded in surveys undertaken as part of this study: white grouper *Epinephelus aeneus* (NT), Madeiran sardinella *Sardinella maderensis* (VU). In addition, the following CH species are likely to be present: catfish *Notoglanidium akiri* (EN), cassava croaker *Pseudotolithus senegalensis* (EN), Atlantic goliath grouper *Epinephelus itajara* (VU), dusky grouper *Mycteroperca marginatus* (VU), gobies C*orcyrogobius lubbocki* (VU) and *Didogobius amicuscaridis* (VU), tarpon *Megalops atlanticus* (VU), royal threadfin *Pentanemus quinquarius* (VU), law croaker *Pseudotolithus senegallus* (VU), and west african seahorse *Hippocampus algiricus* (VU).

Aquatic Mammals:the presence of aquatic mammals within the proposed Project Site cannot yet be confirmed, but as the Bonny River Estuary lies within the range of the following species, it is feasible that they may be present in the system: clawless otter *Aonyx capensis* (NT), and spotted-necked otter *Hydrictis maculicollis* (NT). Atlantic humpback dolphin *Sousa teuszii* (CR), and African manatee *Trichechus senegalensis* (VU), African. have been reported to be present (Luiselli et al., 2012, Olakunle and Ndubisi, 2021)

Terrestrial Mammals: Putty-nosed Monkey (*Cercopithecus nictitans*, EN), African, Black-bellied Pangolin (*Phataginus tetradactyla,* VU) were recorded from community interviews, present in more natural habitats outside the Project area

Aquatic Reptiles:, the presence of the following reptiles in the Bonny River Estuary system has been recorded in the literature: dwarf crocodile *Osteolaemus tetraspis* (VU) and Nile crocolide *Crocodylus niloticus* (VU) (see note below) (Luiselli et al.,.2012),, and turtles- the green turtle *Chelonia mydas* (EN) leatherback turtle *Dermochelys coriacea* (VU) olive ridley turtle *Lepidochelys olivacea* (VU), (Akani and Luiselli, 2009),. In addition, as the Bonny River Estuary lies within the range of the following species, it is feasible that they may be present in the system: slender-snouted crocodile *Mecistops cataphractus* (CR) andand African softshell turtle *Trionyx triunguis* (VU).

Terrestrial Reptiles: Marine Iguana (Amblyrhynchus cristatus, VU) was observed on more natural shorelines in close proximity of the Project area, whilst the African Dwarf Crocodile (Osteolaemus tetraspis, VU) was recorded from community interviews.

Flora: isolated patches of Mangrove swamp habitat, including *Rhizophora racemosa*, *R. harrisonii* and *R. mangle*. Also, *Laguncularia racemosa, Avicennia germinans* and mangrove Salt Fern (*Acrostichum aureum).* All these species are of Least concern, but mangrove habitats overall are under pressure by modification, land reclamation and alien invasive plants.

Note on Nile Crocodile

A recent genetic study has shown that West African crocodile (*Crocodylus suchus*) is distinct from the East African Nile Crocodile (*C. niloticus*). *C. suchus* is frequently misidentified as *C. niloticus*. *C. niloticus* is still relatively widespread throughout east, central and south Africa, but *C. suchus* is restricted to West Africa as it has already disappeared from other African regions (Hekkala et al. 2011). This new species hasn't been evaluated yet by the IUCN Red List, but it is likely to be listed as CR given its small remaining range and the threats on the species. It is possible that this species is present in the Bonny River Estuary.

Terrestrial Biodiversity

The study area contained modified and sand-filled areas (dominated by grasses and sedges) covering most of the Project area, patches/relics of riparian mangrove vegetation along the quay-side, and secondary forest consisting of mangrove swamp vegetation (across the river body, about 2.3 km away for the proposed project site). Despite indigenous species being present within habitats on and adjacent to the Project site, these are modified and under immense pressure from alien invasive plants.

Aquatic Biodiversity

The estuarine biodiversity in the site has already been highly impacted, with mangroves largely removed. However, the site still has the potential to support important estuarine biodiversity, particularly on the intertidal mudflats. The Project will remove any remaining intertidal estuarine habitat on the site, which will be limited to berth pocket.

4.6 Socio-Economic Activities

4.6.1 Introduction

This *Section* describes the context of the socioeconomic environment potentially affected by the Project. The baseline has been established using primary and secondary data collected during the following two processes:

1. On-site baseline data collection to gather primary data from the Project-affected communities.
2. Additional desktop research conducted, where necessary, to close any data gaps.

Primary Data Collection Methodology

Primary data was collected through sampling of the Project-affected communities (*SIAHIA Cultural Heritage Report, 16 August 2023, ECSL Consulting*). Prior to the commencement of fieldwork, community gatekeepers were informed of the proposed study to obtain their consent and to facilitate access for fieldworkers. A non-proportional sample of two hundred and fifty (250) respondents were surveyed from the selected communities through questionnaire administration refer to **Annexure 4.8.** Given the lack of reliable population data for the Study Area, it was not possible to select respondents proportional to community size. For further gathering of qualitative data, Focus Group Discussions (FDG), Key Informant Interviews (KII), and Participatory Appraisal techniques were used.

Secondary Data Collection Methodology

In addition, desktop research was conducted to corroborate and complement outcomes of primary data collection. Secondary data was collected through the following methods:

- Review of official publications such as the National Population Commission and the National Bureau of Statistics; and
- Additional desktop-based research, using reliable sources, where necessary.

4.6.2 Study Area

4.6.2.1 Social Area of Influence

The surveyed Project-affected communities fall into two distinct categories. The first is Ogu which is part of the Ogu-Bolo Local Government Area of Rivers State, and the second is Onne which is in Eleme Local Government Area (LGA) of Rivers State. As of the 2006 census[14], Ogu-Bolo has an area of 125.3km^2 with a population of 75,282 and population density of 864.4 per km^2. Eleme has an area of 150,1km^2 with a population of 190,194 and population density of 1,823 per km^2. As per the 2006 census, the Ogu-Bolo LGA had a 51.21% male and 48.79% female population whereas Eleme LGA had 51.71% male and 48.29% female population. The population above 65 years was 3.5% in Ogu-bolo, and 2.9% in Eleme LGA. Between the 1991 and 2006 censuses, both LGAs showed 2.3% annual population growth rate which was slightly lesser than the overall Rivers State population growth rate of 2.85%. It is important to note that the Ogu community survey/study includes four settlements, namely the Owo Ogona, Ele, Ikpokiri-1 and Ikpokiri-2.

[14] The last Nigerian census was conducted in 2006. As such, this report necessarily relies on 2006 data, which is assumed to be mostly outdated, and includes estimations and extrapolations based on this data where required.

4.6.2.2 Onne Port Complex

The Onne Port complex is situated on the bank of the Bonny River, which is about 25km south of Port Harcourt, Rivers State, Nigeria. Eleme LGA and Ogu-Bolo LGA share a boundary with Bonny River. Indorama operates an existing port terminal, (OIS Indorama Port Limited), for Urea export which is located within Onne Port Complex. The Onne Port Complex was established as a 'Free Port Zone' (FPZ) to serve as a development catalyst for the oil and gas industry in West Africa. This complex, established in 1982 as the Federal Lighter Terminal (FLT), has consistently expanded, due largely to investments through Public/Private Partnerships. The Onne community of Eleme LGA and the Ogu community of Ogu-Bolo LGA are traditionally considered as the host communities of this port complex.

4.6.3 Governance and Administration

Nigeria is a Federal Presidential Republic, with its capital in Abuja. It is divided into 36 states and one territory: the host state of the Project being the Rivers State. The President acts as both head of state and chief of Government and is directly elected by a qualified majority popular vote and at least 25% of the votes cast in 24 of Nigeria's 36 states. The President is elected for a 4-year term (eligible for a second term).

Eleme Local Government Area has its administrative headquarters in Ogale town and comprises of ten towns which include Ogale, Agbonchia, Aleto, Alesa, Alode, Akpajo, Onne, Ebubu, Eteo and Ekboro..

Ogu-Bolo Local Government Area has its administrative headquarters in Ogu town and comprises four districts and six towns which include Bolo, Ele, Ogu, Wakana, Adiai-Obiofu, Agwe, Amuajie, Ase-Imonita, Ase-Azaga, and Isara.

In addition to formal governance structures, traditional governance plays an important role in the Project host communities. The traditional governance structure at the ethnic and community level are illustrated in Figure 4-5151 below.

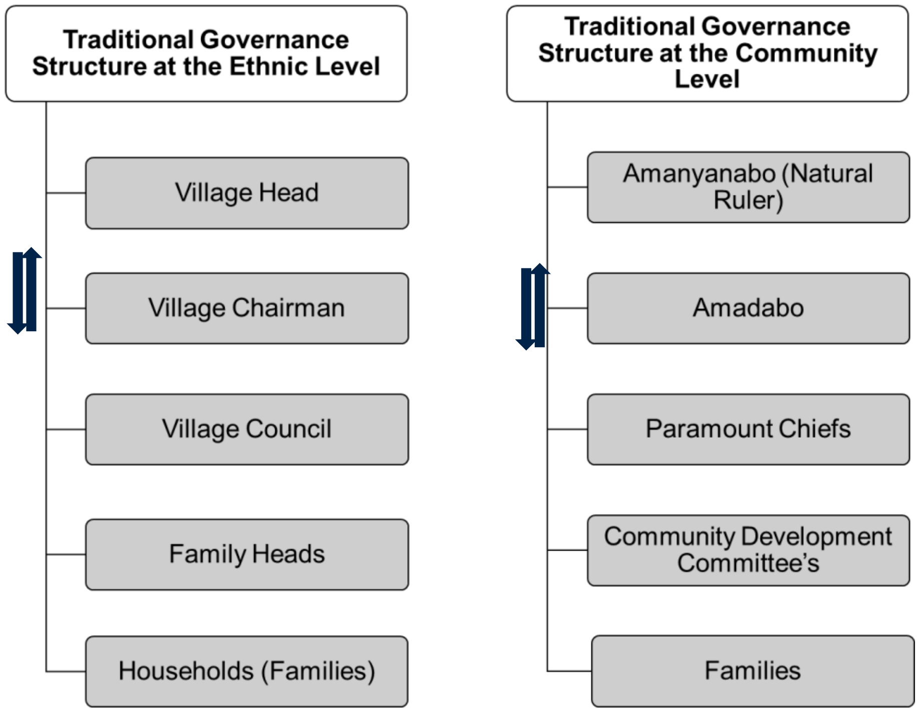


Figure 4-51: Traditional Governance Structures.

4.6.4 Planning and Development

Nigeria is Sub-Saharan Africa's largest economy, with oil comprising the main source of Government revenue. Economic growth since 2008 has been largely driven by the agricultural, telecommunications, and service sectors, with oil production steadily declining since 2012. Despite economic growth and diversification, 62% of Nigeria's population live in extreme poverty. The unemployment rate was 9.79% in 2021, with 70% of the population employed in agricultural activities.

At a national level, the Community and Social Development Project (CSDP) in Nigeria, seeks to strengthen access of the poor to enhanced and improved social services and infrastructure in a sustainable approach. It intends to improve the skills and capability of local government structures and public organisations to support villages and communities and build a strong, efficient partnerships[15].

From secondary research conducted, there is no information on specific planning and development initiatives within the LGAs within the Project's AoI.

4.6.5 Human Rights

The 2022 Freedom in the World Index ranks Nigeria as 'Partly Free'. While Nigeria has made significant improvements to the quality of its elections since the 1999 transition to democratic rule, the 2019 presidential and National Assembly elections, which saw President Muhammadu Buhari re-elected and the All-Progressives Congress (APC) regain its legislative majority. The petroleum industry remains vulnerable to global volatilities and security challenges and corruption at the National level.

[15] The World Bank (2021). Nigeria: The Community-Led Approach that is Helping Inclusive Development

4.6.6 Demographics

The population of Eleme and Ogu-Bolo is relatively small but is predicted to increase steadily. The Table 4-378 is a description of the population size of the study areas, their population projection in 2022, and estimated growth rate.

Table 4-38: Estimated Population of the Study Area.

LGAs	Population 1991 Census	Population 2006 Census	Population Projected 2022	Population Projected 2025	Growth Rate (%)
Eleme	-	190,194	273,500	292,977	2.3
Ogu-Bolo	-	75,282	100,300	115,965	2.3

Source: Computed Values of Estimated Population in the Study Area, 2023 Using NPC, 1991/2006 as Base-year Values

The baseline survey further examined the age-sex distribution in the study areas, with 60% of the respondents being females and 40% being males. This may imply that within the AoI there is a higher female population than males. In Onne, the majority of respondents were 35 years of age or below (45.3%), while 28.7% were between the ages of 36 and 45 years. In Ogu, the majority of the population falls within the bracket of 46 to 55 years (35.2%), while 28% of the respondents were between the ages of 36 and 45 years. The results also concluded that with only 15.2% and 20.6% of the respondents in Onne and Ogu respectively being over the age of 56 years, 70% of the population in each area are classified as falling within the economically active age group.

4.6.7 Education and Literacy

At a national level, Nigeria reports a literacy level of 71.3% among the male population, and 52.7% among the female population. The significant difference in literacy levels is indicative of lower levels of female school attendance.

According to the survey, the majority of the respondents (48.2%) in Onne attended up to post-secondary education, whilst in Ogu the majority of the population (45.7%) had secondary education. 15.2% of the population attended primary school in Onne, while 23.5% of the population attended primary school in Ogu. There are also informal education systems in the study areas, with 28.6% of the population receiving this type of education. These results are summarised in Table 4-38.

Table 4-39: Educational Attainment within the AoI (Source ECSL 2023 Field survey).

LGA	Non-Formal Education (%)	Primary Education (%)	Secondary Education (%)	Post-Secondary Education (%)
Onne	10.3	15.2	26.3	48.2
Ogu-Bolo	18.3	23.5	45.7	12.5

During FDGs, respondents indicated that the general perception of public schools' capacity is low, particularly as a result of high student to teacher ratios and poor infrastructure.

4.6.8 Livelihood Activities

According to the baseline data collected, 44.8% of the respondents in the Onne community are self-employed, 16% are formally employed, 14.4% are public servants, and 24.8% are unemployed. In the

Ogu community, 52.8% of the respondents are formally employed, 17.6% are self-employed, 8% are public servants and 21.6% unemployed. In both areas, the unemployment rate is significantly higher than Nigeria's national unemployment rate of 9.79%. Table 4-39 presents the income distribution in the AoI.

Table 4-40: Income Distribution in AoI.

Income Bracket	Respondents (%)
Onne Communities	
Less than ₦25,000	5.3%
₦25,000 - ₦35,000	15.3%
₦35,000 - ₦45,000	22.6%
₦45,000 - ₦55,000	32.3%
Ogu-Bolo Communities	
Less than ₦25,000	35.8%
₦25,000 - ₦35,000	14.7%
₦35,000 - ₦45,000	10.2%
₦45,000 - ₦55,000	18.6%
Greater than ₦55,000	20.7%

(Source – ECSL 2023 Field data survey)

Table 4-40 presents a breakdown of livelihood activities within the AoI and indicates the gender distribution of categories of livelihood activities identified. In general, there are a greater proportion of females involved in agriculture and agricultural related livelihood activities, whilst a higher proportion of males are involved in non-agricultural livelihood activities. Overall, respondents within the AoI are 78.94% reliant on agriculture related livelihoods, while only 21.06% rely on non-agriculture related livelihoods. As such, any potential Project impacts on natural resources may have significant impacts on community livelihoods.

Table 4-41: Gender Breakdown of Livelihood Activities in the AoI.

Occupational Activities	Gender			Percentage (%)	Agricultural or Non-agricultural activities
Income Activities	**Male**	**Female**	**Total**		
Crop farming	21	43	64	13.3	Agricultural and agricultural related activities **78.94%**
Animal husbandry	9	10	19	3.95	
Aquaculture	5	6	11	2.29	
Capture fishing	31	78	109	27.71	
Fish processing	11	21	32	6.67	
Trading on fish, etc	12	19	31	6.46	

Trading on fishing gears/accessories	10	17	27	5.63	
Trading on foodstuffs and provisions	10	22	32	6.67	
Logging	15	4	19	3.95	
Forest resource gathering	12	23	35	7.29	
Civil/Public service	9	4	13	2.71	Non-agricultural activities **21.06%**
Oil company employee	6	3	9	1.88	
Artisans	13	20	33	6.88	
Transportation (water and land)	19	12	31	6.46	
Politics	6	3	9	1.88	
Other	4	2	6	1.25	
Total	**193**	**287**	**480**	**100**	

(Source – ECSL 2023 Field data survey)

4.6.9 Land Tenure and Land Use

Forest and water resources are extensive in Ogu and Onne communities. The aquatic resources in particular are fish, shrimps, lobsters, and periwinkles, which are obtained from the rivers and tributaries that are in the surrounding communities and settlements. The communities also make use of secondary vegetation and water swamps. Some of the forest products are obtained from these areas. They include non-timber products such as fuel wood, wild fruits, medicinal plants, snails, vegetables, and spices. There are no major restrictions to access of forest resources where shrines and other deities are located or revered.

The land adjacent to the Project site is owned by national government Nigerian Ports Authority (NPA) and leased to various companies, as it is undeveloped. The land for the Project is leased from NPA. The potentially affected urbanised communities, including Onne and Ogu, are likely to have a mix of tenure, such as formal title deeds and informal agreements. The less formal communities, such as Owo Ogono are likely to fall under traditional authorities, with no formal title to the land. The proposed Project is unlikely to impact on land tenure outside of the footprint of the Project.

4.6.9.1 Access to Water

Primary data collected revealed no functional municipal water is available in both Onne and Ogu communities, but individuals have boreholes / wells. Households rely on a combination of boreholes, rain, rivers, and wells as sources of water for drinking and other household activities. This makes households particularly sensitive to any forms of groundwater contamination.

4.6.10 Health

There are several healthcare facilities in the area of Onne and Ogu such as hospitals, private medical clinics, birth clinics/facilities, and health care centers. However, there are more private clinics, maternity clinics, medical laboratories, and pharmacies in Onne than there are in Ogu. Additionally, it has been observed that traditional healthcare practitioners are also present in the AoI.

With regards to the utilisation of health services it was found that a higher percentage of respondents prefer to utilise hospital/health centres as their source of medical treatment, while lower percentages of respondents preferred to use a chemist/pharmacy, traditional medical practitioners, and churches respectively. The use of clinics for birth delivery is relatively low. Patients prefer to go to traditional medical practitioners, churches, and untrained traditional birth attendants. The reasons for this include the high cost of medical treatment, poor quality of healthcare, and religious beliefs.

4.6.10.1 Prevalent Diseases

According to the baseline line data collection, the most common forms of ill health in the communities are malaria and typhoid fever. Other prevalent ailments are upper respiratory tract infections, skin diseases, measles, dysentery, and diarrhoea. Non-communicable diseases like hypertension and diabetes have increased in the communities over time.

4.6.11 Infrastructure and Public Services

As compared to neighbouring African countries, Nigeria has a relatively advanced system of power, road, rail, and information and communication technology infrastructure. However, challenges exist in terms of insufficient electricity generation and transmission capacity, low levels of piped water and sanitation coverage, and deteriorating road networks as a result of lack of maintenance[16]. Likewise, Nigeria’s public administration systems exacerbate poor service delivery, contributing to concern that they are unable to adequately service the country’s already large and growing population. Furthermore, pervasive corruption is a significant contributor to poor levels of service delivery[17].

Plate 4-2: Educational Attainment and Facilities in the study Area

[16] Foster, V. and Pushak, N. 2013. *Nigeria's Infrastructure: A Continental Perspective.* Policy Research Working Papers, World Bank Group.
[17] Okafor, C. 2023. *The Challenges of Public Service Delivery in Nigeria: Engaging the New Public Service Approach*. African Renaissance, Vol. 20, No. 2.

Plate 4-3 Informal Financial Services in the Study Area

Plate 4-4 Sign Post of Some Churches in the Study Area

Plate 4-4 Community Shrine in Ogu

Table 4-41 summarises access to infrastructure within the AoI. However, for the purposes of impact assessment, the info collected, and the national scenario outlined above will likewise be applicable to the communities within the AoI.

Table 4-42: Infrastructure in the Study Area

Infrastructure	Condition / Availability
Electricity	Project-affected communities are linked to the national grid, but electricity supply is unreliable. Communities source and maintain their power through small-scale private generation, lanterns etc. Solar streetlights installed by Indorama as CSR project in Ogu communities are evident refer to annexure 4.9 for detailed Indorama CSR to Onne and Ogu. .
Water	No functional municipal water is available in both Onne and Ogu communities, but individuals have boreholes / wells.
Roads /Drainage	The East-West Road, a gateway to industrial hubs, traverses through the target communities. Internal road networks and drainage systems are present but not maintained causing flooding during the wet season. Drains are clogged with debris.
Local Markets	The studied communities have their local markets which holds daily. There are some malls/departmental stores in Onne.
Transportation	The area is traversed by major highway, the East-West Road that begins in Warri and ends in Eket. The highway is used extensively by trucks transporting loads for industry. Cars, tricycles (keke napep) and motorcycles are the mode of transportation used by the public. The Ogu communities also used water boats.
Telecommunications	Project-affected communities have access to public communication facilities like telephones and postal services. The networks of the major telecommunications companies (Glo, MTN, and Airtel) are available.
Schools	The studied communities have primary and secondary schools. Onne have Nigerian Naval College
Hospitals	The studied communities have Primary health centres.

(Source – ECSL 2023 Field data sampling)

4.6.12 Assumptions on the Socio-economic Baseline

The following assumptions are applicable to the socioeconomic baseline:

- The data provided are from primary data / information collected and prepared by ECSL; and
- The study communities are mostly aligned to the Project-affected communities, and where Project-affected communities were not involved in the study, their demographic characteristics are similar to those of the study communities.

The following limitations should be considered with regards to this socioeconomic baseline:

- Where recent data is not available, professional judgement has been used to extrapolate data reflecting the current context; and
- Data sets for Project-affected communities are often limited or non-existent; it is therefore necessary to rely on data and information which is applicable at a regional or national level.

4.6.13 Summary of Key Socio-economic Sensitivities

- **Impacts on natural resource-based livelihoods:** The study areas rely heavily on agriculture and land use for their livelihoods. Any potential loss of environmental habitats or biodiversity loss will impact the surrounding communities negatively. Additionally, it was found that the surrounding communities also rely on fishing as a source of livelihood. Any impact to this during the construction and operation phase such as increased pollution levels and water contamination may result in impacts on natural resource-based community livelihoods.
- **Water contamination**: Surrounding communities rely on groundwater (boreholes and wells) as a water source. Another source of water is surrounding rivers and oceans. If there is pollution to any of these water sources, community livelihoods and household activities will be impacted.
- **Close proximity of communities to site**: The construction phase could result in disruption to nearby communities to the north and north-west. The access to the site (roads and entrances) should be considered to minimise impacts to adjacent communities.
- Construction noise, dust, traffic must be managed to prevent impacts on nearby communities.
- Changes in local air quality due to the proposed project could negatively impact local communities, who are considered vulnerable due to their (assumed) low socio-economic status.
- **Site access through Onne community**: Primary access to the site is along the main roads, including Ejaka-Wakanda Road which runs through the centre of the Onne community. Increased presence of heavy vehicles during construction, as well as trucks carrying urea for export during operation, may have an impact on traffic levels as well as the quality of local roads. Furthermore, the movement of heavy vehicles through a densely populated town centre presents a number of hazards such as traffic accidents or injuries or fatalities of pedestrians.
- Reduced of community cohesion and access to basic services during construction, due to influx of labour and outsiders (Medium)
- Unmet expectations of local employment, procurement, and socio-economic development (Medium)
- Disruption to fishing livelihoods through environmental impacts and port traffic (low)
- Community health and Safety risks, due to construction activities and security personnel (low).

4.7 Cultural Heritage

This *Section* presents the baseline for cultural heritage and assesses the nature, distribution, and value (significance) of cultural heritage resources for the construction and operation of the MM FZE Port Facility at the Federal Ocean Terminal of the Eleme Local Government Area, Rivers State, Nigeria (hereafter referred to as the Project).

The information presented in this baseline chapter draws on desk-based research, remote sensing, historic mapping, and field survey of the Project Area of Influence (AoI).

4.7.1 Methodology

4.7.1.1 Baseline Methodology and Approach

This Cultural Heritage Baseline Study has been prepared using the guidance on Heritage Impact Assessments for Cultural World Heritage Sites (International Council on Monuments and Sites,[18] ICOMOS[19]) and international guidance (ICOMOS and IFC PS8[20]). No national guidance currently exists on methodology for assessment of impacts on Cultural heritage within Nigeria.

Cultural Heritage resources were identified through the following:

- Desk-based research, including remote sensing; and
- Field Survey for tangible and intangible Cultural Heritage.

Desk-based Research

The following information and sources were consulted during desk-based research of the Cultural heritage:

- Socio-economic and Cultural Heritage Report for MM FZE Port ESIA 2023;
- Publicly available remote sensing data including satellite imagery; and
- Published and available academic research of the region

Field Survey for Tangible Cultural Heritage

A field survey for tangible cultural heritage was conducted by ECSL in October 2023. The results of the field survey are presented in *Section 4.7.6* (Key Baseline Findings).

[18] ICOMOS, 49-51 rue de la Fédération 75015 Paris, France in collaboration with the World Heritage Centre. 2011. Guidance on Heritage Impact Assessments for Cultural heritage Properties. A publication of the International Council on Monuments and Sites. Available at: iccrom.org. Accessed on: 31/03/2022

[19] This guidance has recently been updated and can be found here: https://www.iccrom.org/sites/default/files/2018-07/icomos_guidance_on_heritage_impact_assessments_for_cultural_world_heritage_properties.pdf

[20] https://www.ifc.org/wps/wcm/connect/topics_ext_content/ifc_external_corporate_site/sustainability-at-ifc/policies-standards/performance-standards/ps8

Field Survey for Intangible Cultural Heritage

Data collection as part of the social baseline consisted of household surveys representative of the Social AoI, including specific questions designed to identify and characterised cultural heritage such as:

- Traditions, crafts, rituals or festivals;
- Foraging for specific food or other plants;
- Making crafts from materials sourced from a special location; using water from a special location;
- Any sacred trees, rocks, or streams/rivers;
- Local celebrations specific to a location;
- Special grave visits on a special day; Rituals associated with funerals
- Hunting/catching animals on a special day specific to a location, etc.
- Legends or events of feats, heroes, fairies, dragons etc., attributed to a specific location;
- Historical events (locally or nationally important) associated with a specific location; and
- Locations made famous through literature

4.7.2 Limitations

The Cultural Heritage Baseline was developed based on the Project Description as per September 2023. Where specific information or details are not provided at the time of writing, assumptions have been made and a precautionary approach has been taken.

4.7.3 Topographic and Geological Context

As mentioned previously, the proposed Project is located within the Onne Port Complex approximately 20 km to the south of the manufacturing plant at the existing Indorama Complex, within the coastal plains of the eastern Niger Delta basin. The surface geology consists of fluvial sediments transported by the Niger River tributaries with Quaternary Upper and Low Deltaic deposits, providing the potential for buried terrestrial and marine archaeology to be present, though preservation due to rainfall, temperature and topography may be poor.[21] The land is typically low-lying with poor drainage and a combination of thick vegetation and seasonally cultivated soil,[22].

Port Harcourt, the second largest port in Nigeria lies approximately 20km northeast and upriver of the Project AoI. The large-scale shipping traffic and changes made to the Bonny River in the past, including the dredging activities in the late 1920’s and landfill more recently in 2015, may impact the archaeological potential of the site. There exists however the potential for buried archaeological remains to be present during the construction phase.

[21] Report No: C-202111 Soil Investigation Report FISAS. January 2022.
[22] Report No: NG-LD21-08 Topographical Survey Report. Atlas Geo Solutions. October 2021.

4.7.4 Literature review of Nigerian archaeology studies to date

Archaeological research began relatively late in south-eastern Nigeria, with the first excavation in the region taking place in 1960.[23] Prior to this more informal research took place in 1910, led by European scholar Frobenius who focussed on recovering objects rather than documenting archaeological context. The discovery of terracotta, copper and bronze objects spurred further research, leading to a flurry of researchers interested in the collection of Nigerian artefacts through archaeological surveys.

In 1943 the Nigerian Department of Antiquities (NDA) was established in Nigeria to oversee archaeological works and in the late 1960s the first systematic surveys were carried out by the NDA in partnership with University of Cape Town, University or Ibadan, University of Ile-Ife and University of Nigeria. Excavations such as the Igboukwu excavations in Anambra State, southeastern Nigeria, yielded large quantities of glass beads, intricately produced bronze artefacts, potsherds, and various iron tools which revealed the intrinsic value and ingenuity of the surrounding Igbo kingdom. Figure 4.52 locates the Igbo region of Nigeria on a map in relation to the Project AoI.

Archaeological studies in south-eastern Nigeria in more recent years have shed light on the technology used to extract raw materials in the past for the production of stone, metal tools and pottery. Traditional methods of raw material extraction continue into the 21st century within the Igbo region with evidence of iron smelting, pottery making and tin mining (Figure 4.53).

[23] Ngonadi, C. Archaeology of Igboland, Southeastern Nigeria. Oxford Research Encyclopedia of Anthropology. Retrieved 18 Feb. 2023, from https://oxfordre.com/anthropology/view/10.1093/acrefore/9780190854584.001.0001/acrefore-9780190854584-e-556.

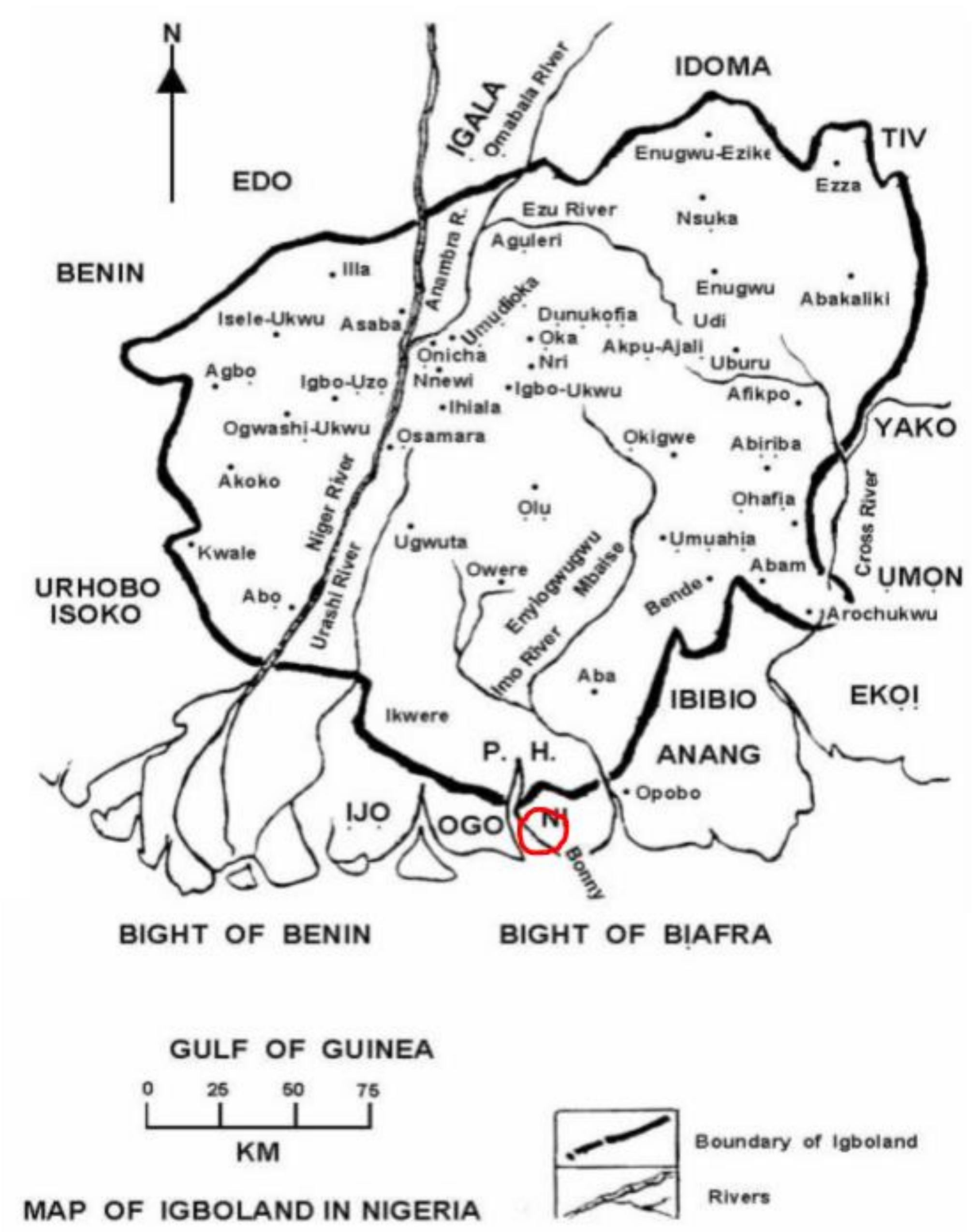


Figure 4.52: The extent of Igboland, with approximate Project AoI circled in red.[24]

[24] Validating perceptual objective listening quality assessment methods on the tonal language Igbo - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Map-of-Igboland-in-Nigeria_fig2_27353122 [accessed 18 Feb, 2023]

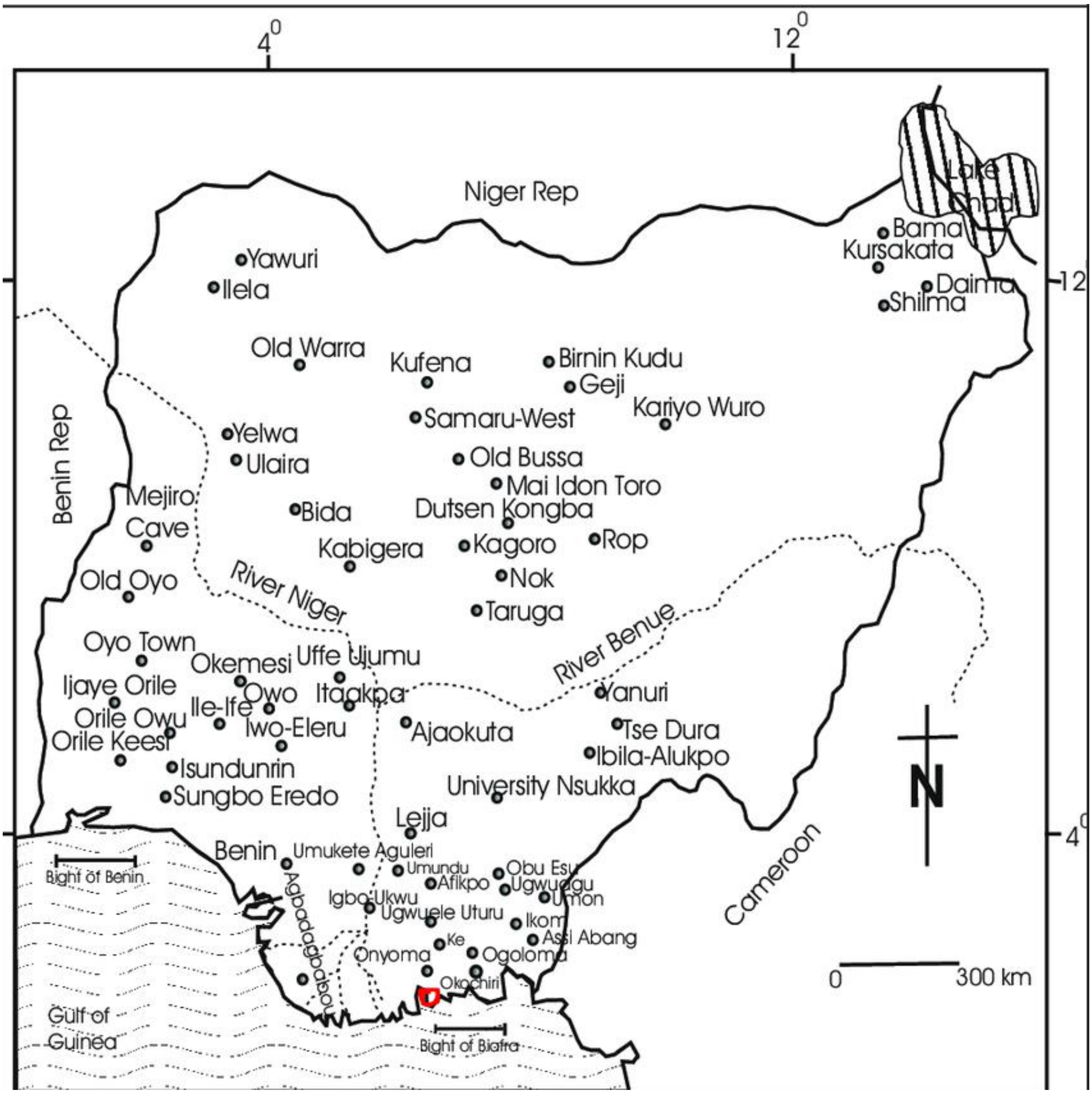


Figure 4.53: Locations for studied archaeological sites in southeast Nigeria in relation to the Project AoI[25]

[25] Babalola, Abidemi & AJEKIGBE, PHILIP. (2007). Poverty Alleviation in Nigeria: Need for the Development of Archaeo-Tourism. Anatolia. 18. 223-242. 10.1080/13032917.2007.9687203.

4.7.5 Archaeological and Historic Background

This *Section* provides a period-by-period overview of the archaeology and history of the region, wider study area and Project Area of Influence. Each period concludes with a preliminary assessment of the potential for cultural heritage resources to be present within the Project AoI.

Early Stone Age (c. 1.5 ma BCE – c. 130,000 BCE)

Very little is known about the Early Stone Age (ESA) in West Africa generally, partly due to historic research interests and partly due to geological inconsistencies, for example the lack of faulting to expose Early Quaternary sediments that we see across East Africa. The earliest reported ESA identified in West Africa remains controversial as pebble choppers similar to the Oldowan complex has been found in multi-period assemblages, and whilst an Oldowan presence in West Africa is possible there is no clear evidence yet to support this[26].

The Acheulean in contrast to the Oldowan, has been identified in abundance throughout Nigeria, however there are currently very few direct age estimates from primary context. Mai Idon Toro, an archaeological site in Northern Nigeria yielded Acheulean stone artefacts for researchers from the 1920's through to the 1960's and have been studied further out of situ and without the knowledge of the dilapidated state of the archaeological site[27].

As mentioned in section 4.7.3 Topographical and Geological context, the high rainfall and temperature contributes to poor preservation of ESA material within the region. The estuarine environment of the Bonny River adjacent to the Project AoI has created extensive sedimentary deposition and erosion in a generally low-lying part of southeastern Nigeria. This results in a potentially **low potential** for ESA cultural heritage resources to be present within the Project AoI.

Middle Stone Age (c. 130,000 BCE – c. 12,000 BCE)

The emergence of the chronological record for the Middle Stone Age (MSA) in Nigeria and West Africa in general indicates that core and flake technologies were present from the Middle Pleistocene at least until the Pleistocene Holocene boundary (c. 126,000 – 12,000 BCE)[28]. Evidence for MSA archaeological material in low-lying forested areas such as the Project AoI remains questionable however inter-regional styles and differences in technological style may vary based on raw material availability.

MSA assemblages in West Africa in general have been typologically identified based on links to other regions, for example the 'Sangoan' and 'Mousterian', though more recently local terms have been used to describe MSA technologies throughout the region, such a 'Tiemassessanian'. In northern Nigeria

[26] Scerri, EM.L. 2019. Review of the book The Middle Stone Age of Nigeria in its West African context by Philip Allsworth-Jones. Oxford Archaeopress. Published in Azania doi.org/10.1080/0067270X.2019.1676052

[27] Jock, Agai & Agai, Jock. (2021). A Report on the History of the Acheulean Industry of Mai Idon Toro in the Central-Region of Nigeria. IUP Journal of History and Culture. 1. 29-41. 10.30560/ch.v1n1p29.

[28] Scerri, EM.L. 2019. Review of the book The Middle Stone Age of Nigeria in its West African context by Philip Allsworth-Jones. Oxford Archaeopress. Published in Azania doi.org/10.1080/0067270X.2019.1676052

there are two sites of considerable importance, Nok and Zenabi which yielded an abundance of disc-cores and blades with prepared platforms, in contrast to the 'Sangoan' industry which dominates the South with a Levallios technology[29].

Based on the scarce evidence of MSA archaeological material in southern Nigeria, particularly in low-lying areas of high fluvial and estuarine activity, the potential for MSA cultural heritage to be present within the Project AoI is **low**.

Later Stone Age (c. 12,000 BCE – c. 1 BCE)

The Later Stone Age (LSA) sees significant innovation and technological diversification including micro and macro-lithic assemblages and a marked reduction on tool size, particularly geometric microliths seen across Nigeria dating to c. 12,000 BCE in basal stratigraphic lenses at the Iwo Eleru Rock Shelter, southwest Nigeria. The environment surrounding this well-known site is predominantly low-lying rainforest, indicating the **low to moderate** potential for buried LSA archaeological material to exist within the project AoI.

Pottery and agriculture is thought to have developed in c. 8000 BCE in the region, linked with the introduction of ground-stone axes,[30] which signifies a change in ecological conditions. These axes were used for felling trees, allowing for agricultural expansion. Linguistic studies suggest that some of the earliest plants cultivated in southern Nigeria include oil palm, kolanuts, yams, and wine palm.[31] The appearance of trapezoid tools from c.1500 BCE also suggest that grasses were exploited.[32]

Iron Age (c. 1 CE– c. 1600 CE)

The agricultural growth in the first millennium CE was likely helped by the early production of iron tools used for bush clearance and land tilling.[33] The rapid spread of iron production in this period suggests that there was either population movement, effective trade networks from iron production sites, or both.[34]. Analysis of glass beads found at the Igbo-Ukwu burial site (140 km north of site) dated between the tenth and fifteenth centuries CE suggest established trade connections up the River Niger to Gao, on to Mesopotamia, and perhaps even as far as India.[35] The evidence for long-distance over-land trade indicates that Igboland was connected to global trade networks long before direct European contact from the sixteenth century. Moreover, the use of river systems as transport networks may mean that there is a **moderate potential** for archaeological evidence of this to be found at the Project AoI due to its proximity to an established river transport network.

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[29] Scerri, EM.L. 2019. Review of the book The Middle Stone Age of Nigeria in its West African context by Philip Allsworth-Jones. Oxford Archaeopress. Published in Azania doi.org/10.1080/0067270X.2019.1676052

[30] Emuobosa A. Orijemie, 'The Archaeobotany of the Later Stone Age (LSA) in Nigeria: A Review' in *Plants and People in the African Past*, ed. A. M. Mercuri (2018), p. 370

[31] Emuobosa A. Orijemie, 'The Archaeobotany of the Later Stone Age (LSA) in Nigeria: A Review' in *Plants and People in the African Past*, ed. A. M. Mercuri (2018), p. 364.

[32] Emuobosa A. Orijemie, 'The Archaeobotany of the Later Stone Age (LSA) in Nigeria: A Review' in *Plants and People in the African Past*, ed. A. M. Mercuri (2018), p. 364

[33] Joseph C. Chukwu, 'Traditional Igbo Building Architecture: An Historical Perspective', *Arts and Design Studies*, 34 (2015), p. 7

[34] Susan Keech McIntosh, 'Igbo-Ukwu at 50: A Symposium on Recent Archaeological Research and Analysis', *African Archaeological Review* (2022), p. 376

[35] Susan Keech McIntosh, 'Igbo-Ukwu at 50: A Symposium on Recent Archaeological Research and Analysis', *African Archaeological Review* (2022), pp. 376-377.

Religion was an important facet of Igbo society, influencing other aspects of life such as law.[36] As with the history, this theology is difficult to reconstruct as the concept of *Chukwu* (a supreme god) was already a complex formation of different (and varying) motifs and beliefs within the Igbo religious experience prior to its appropriation by Christian missionaries in the nineteenth century.[37] Nevertheless, it is clear that reincarnation was (and still is) pivotal within the Igbo social system as they believe that their ancestors return to temporal life after death.[38] This creates the sense that the living and the dead occupy the same universe, along with a pantheon of supernatural powers that control the heavens and earth.[39]

An important part of this belief is of living and dead ancestor worship, including feasting and daily invocations.[40] This extended to burial where the dead are prepared for their journey into eternity, with every caution being observed to ensure that the dead person is in a state of contentment.[41] Although few people now engage the rites of the ancestors, many of the practices have shifted in the present. Indeed, the *Alommo* (the annual feast of the ancestors) has transitioned into *emume iwaji ohuru* (new yam festival).[42] Therefore, it is important to view the present intangible culture of the communities surrounding the Project AoI with the **possibility of complex religious change with considerable time depth**.

In summary, there is **low to moderate potential** for archaeological evidence to be found within the subject area from the Iron Age, partially due to the dredging of the Bonny River in the 1920s. However, there is a **high potential** for intangible cultural practices to exist in current communities near to the subject area that originated in the Iron Age.

European Contact and Colonial Era (c.1550 – 1960)

The volume of goods within the established global trade increased dramatically with the arrival of European traders in the later fifteenth century due to the size of the European ships.[43] Initially, the main exports from the area were gold, ivory, gum, timber, pepper, and slaves (already an established facet of the local economy) in exchange for European manufactured goods such as textiles, firearms, and spirits.[44] However, by the end of the seventeenth century the demand for slaves had greatly

[36] Emmanuel C. Onyeozili and Obi N. I. Ebbe 'Social Control in Precolonial Igboland of Nigeria', *African Journal of Criminal Studies*, 6 (2012), p. 31.
[37] Chukwuma Azųonye, 'Igbo Folktales and the Evolution of the Idea of *Chukwu* as the Supreme God of Igbo Religion', *Nsukka Journal of Linguistics and African Languages* (1987), p. 44.
[38] Emmanuel C. Onyeozili and Obi N. I. Ebbe 'Social Control in Precolonial Igboland of Nigeria', *African Journal of Criminal Studies*, 6 (2012), p. 31.
[39] Emmanuel C. Onyeozili and Obi N. I. Ebbe 'Social Control in Precolonial Igboland of Nigeria', *African Journal of Criminal Studies*, 6 (2012), p. 31.
[40] Onukwube Alex Alfred Anedo, *Neglect of Ancestors (Ndiichie): The Bane of Modern Igbo Problems* (2008), pp. 6-10
[41] Onukwube Alex Alfred Anedo, *Neglect of Ancestors (Ndiichie): The Bane of Modern Igbo Problems* (2008), p. 6
[42] Onukwube Alex Alfred Anedo, *Neglect of Ancestors (Ndiichie): The Bane of Modern Igbo Problems* (2008), pp. 10-11
[43] P. A. Oguagha, "The Impact of European Trade on Igbo-Igala Commercial Relations in The Lower Niger C. 1650-1850 A.D.", Journal of the Historical Society of Nigeria, vol. 11, no. 3/4, (1982) p. 14. <http://www.jstor.org/stable/41857115.> [Accessed 5 Oct. 2023].
[44] P. A. Oguagha, "The Impact of European Trade on Igbo-Igala Commercial Relations in The Lower Niger C. 1650-1850 A.D.", Journal of the Historical Society of Nigeria, vol. 11, no. 3/4, (1982) p. 14. <http://www.jstor.org/stable/41857115.> [Accessed 5 Oct. 2023].

increased.[45] Igboland experienced the most intensive slave-trading activity in West Africa, with approximately 75% of total exports from the area between 1640 and 1800 being enslaved peoples.[46]

The direct contact that Europeans had with members of Igboland at this point was minimal outside of the coastal hinterland.[47] However, the Project AoI sits within this hinterland, approx. 25km upstream from Bonny, one of the largest trading ports in western-central Africa during the height of the transatlantic slave trade.[48] Indeed, there is consensus amongst academics that by the mid-seventeenth century the waterways of the River Niger, including the Bonny River where the Project AoI is situated, were transformed into a major hub for commerce and exchange of goods.[49]

Therefore, it is likely that there is **moderate potential** for encountering archaeological evidence of maritime trade, including marine archaeology. The economic migration towards the coast and the number of enslaved people passing through Igboland would have caused a major demographic shift throughout the region. It is possible this may also be seen in archaeological evidence from the Project AoI.

By mid-nineteenth century, the forced trafficking of enslaved peoples out of the Bights of Benin and Biafra had all but ceased.[50] Following the abolition of the slave trade in 1807 the British Royal Navy opened a trade route with the coastal towns driven by the palm oil industry. This became the economic basis for the region.[51] At the turn of the twentieth century the British Empire attempted to seize these resources, and their ultimate economic benefit, by military force throughout the whole of what is now Nigeria as part of the wider European ‘Scramble for Africa’.

The military invasion of Igboland did not take place until 1901.[52] However, the arrival of the British prior to and during lead to increased encounters between Igbo and other communities around the Niger River and Delta. The colonialism of Igboland changed traditional cultural practices, as noted above. Christianity and individualism fundamentally shifted the focus of the social structure away from communalism and ancestor worship towards Western practices.[53] This can be seen in the introduction of the Igbo rectangular house designs,[54] as well as the construction of Christian churches. The changing design in these tangible buildings represent the shifting intangible cultural practices in Igboland during the colonial period. There is a **high potential** for some of these buildings to be still present in the villages surrounding the Project AoI.

[45] P. A. Oguagha, “The Impact of European Trade on Igbo-Igala Commercial Relations in The Lower Niger C. 1650-1850 A.D.”, Journal of the Historical Society of Nigeria, vol. 11, no. 3/4, (1982) p. 14. <http://www.jstor.org/stable/41857115.> [Accessed 5 Oct. 2023].
[46] John N. Oriji, ‘Chapter 8: Igboland, Slavery, and the Drums of War and Heroism’ in *Fighting the Slave Trade: West African Strategies*, ed. Sylviane A. Diouf (2017), p. 121.
[47] P. A. Oguagha, “The Impact of European Trade on Igbo-Igala Commercial Relations in The Lower Niger C. 1650-1850 A.D.”, Journal of the Historical Society of Nigeria, vol. 11, no. 3/4, (1982) p. 14. <http://www.jstor.org/stable/41857115.> [Accessed 5 Oct. 2023].
[48] Klas Rönnbäck, ‘The Slave Trades out of Africa’ in *The History of African Development*, ed. Ewoit Frankema, Ellen Hillboom, Ushehwedu Kufakuriani, and Felix Meier zu Salhausen (2020), p. 6.
[49] P. A. Oguagha, “The Impact of European Trade on Igbo-Igala Commercial Relations in The Lower Niger C. 1650-1850 A.D.”, Journal of the Historical Society of Nigeria, vol. 11, no. 3/4, (1982) p. 14. <http://www.jstor.org/stable/41857115.> [Accessed 5 Oct. 2023].
[50] Klas Rönnbäck, ‘The Slave Trades out of Africa’ in *The History of African Development*, ed. Ewoit Frankema, Ellen Hillboom, Ushehwedu Kufakuriani, and Felix Meier zu Salhausen (2020), p. 6.
[51] David Pratten, ‘Currency & Conflict in Colonial Nigeria’ in *The Political Economy of Everyday Life in Africa* (2017), p. 72.
[52] O. N. Njoku, ‘Colonialism and the Decline of the Traditional Metal Industry of the Igbo, Nigeria’, *Interario*, 15 (2), pp. 60-61.
[53] Joseph C. Chukwu, ‘Traditional Igbo Building Architecture: An Historical Perspective’, *Arts ad Design Studies*, 34 (2015), pp. 10-11
[54] Joseph C. Chukwu, ‘Traditional Igbo Building Architecture: An Historical Perspective’, *Arts ad Design Studies*, 34 (2015), p. 11

Port Harcourt (20km Northeast of Project AoI, upriver) was established by the colonial administration in 1912 to export coal from the region.[55] The Port is situated thirty-three miles inland as it is the first area of solid land after the unbroken stretch of mangroves that extend down to the coast.[56] In the 1920s the Bonny River was dredged to increase its navigable depth.[57] This **may impact the marine archaeological potential of the Project AoI** as there is a chance that archaeology within the river bed has been disturbed or removed. In the 1950s oil was discovered in the Niger Delta, leading to the rapid growth and development of the Port as a centre for oil exploitation.[58]

In summary, there is **moderate potential** for archaeological evidence of trade to be found within the study area, although marine archaeology may have been disturbed by the dredging of the River Bonny. There is **high potential** for buildings from the Colonial Era to be present in the villages surrounding the Project AoI.

Independence (1960 – present day)

Nigeria claimed independence from the United Kingdom in 1960, leaving Igboland confined mostly to the southeast region of Nigeria. From the mid-1960s there was increasing political turmoil, the beginning of which was marked by the January 1966 coup.[59] The intensifying political tensions and ethnically motivated violence led to the splintering of Nigeria into twelve states and the creation of the Republic of Biafra where the Project AoI is located.[60] The Republic of Biafra was not recognised by the Nigerian Government as a sovereign state independent of Nigeria, which eventually led to a full-blown war on the 6th July 1966.[61]

There is **moderate archaeological potential** for evidence of the civil war to be seen on the landscape surrounding the town of Aba (50km Northwest from Project AoI) and Port Harcourt (20km Northeast from Project AoI), both important strategic Biafran cities in the conflict.[62] Biafra became part of Nigeria once again in 1970 with military support from the United Kingdom however the tactics used to reunite Biafra and Nigeria remain controversial.[63]

In summary, there is **moderate potential** for archaeological evidence from post-Independence, including the Civil War, to be found within the study area due to its proximity with important strategic centres. Moreover, there is a **high potential** for oral knowledge about the recent history of Port Harcourt and the surrounding areas (including the Project AoI) to be present within the communities surrounding the Project AoI.

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55 Toyin Falola, Ann Genova, and Matthew M. Heaton, *Historical Dictionary of Nigeria* (2018), p. 305

56 Ayodeji Olukoju, 'Playing Second Fiddle: The Development of Port Harcourt and Its Role in the Nigerian Economy', *International Journal of Maritime History* (1966), p. 107

57 Ayodeji Olukoju, 'Playing Second Fiddle: The Development of Port Harcourt and Its Role in the Nigerian Economy', *International Journal of Maritime History* (1966), p. 110

58 Akachi Odoemene, ''Agony in the Garden': Incongruity of Governance and the Travails of Port Harcourt City, Nigeria, 1912-2010', *Africana: The Niger Delta* (2011), p. 113

59 Johnson Olaosebikan Aremu and Lateef Oluwafemi Buhari, 'Sense and Senselessness of War: Aggregating the Causes, Gains and Losses of the Nigerian Civil War, 1967-1970', *IAFOR Journal of Arts and Humanities* (2017), p. 63

60 Johnson Olaosebikan Aremu and Lateef Oluwafemi Buhari, 'Sense and Senselessness of War: Aggregating the Causes, Gains and Losses of the Nigerian Civil War, 1967-1970', *IAFOR Journal of Arts and Humanities* (2017), p. 65.

61 Johnson Olaosebikan Aremu and Lateef Oluwafemi Buhari, 'Sense and Senselessness of War: Aggregating the Causes, Gains and Losses of the Nigerian Civil War, 1967-1970', *IAFOR Journal of Arts and Humanities* (2017), p. 66

62 Mathews, Martin P. (2002). Nigeria: Current Issues and Historical Background. Nova Publishers. p. 38. ISBN 1-59033-316-0; Akachi Odoemene, ''Agony in the Garden': Incongruity of Governance and the Travails of Port Harcourt City, Nigeria, 1912-2010', *Africana: The Niger Delta* (2011), p. 115

63 Minogue, Martin; Judith Molloy (1974). African Aims & Attitudes: Selected Documents. General C. O. Ojukwu: CUP Archive. p. 393. ISBN 0-521-20426-7.

Intangible Cultural heritage

The two Local Government Authorities (LGA) within the Project AoI are Ogu and Eleme communities, both are key stakeholders, and host communities to the Onne Port complex where the proposed Project is situated.

Ancestral worship has been identified in previous baseline surveys as a form of traditional religion, with sacrificial rituals performed at designated places known as sacred areas or shrines in order to service, maintain and protect families or communities. Recognised deities are associated with these families or communities, for example Eleme indigenes within the community surrounding the Project footprint are regulated by belief in the continued presence of the ancestors of each family as well as existence of deities with supernatural powers.

Most of the land associated with sacred rituals has been sold or converted for commercial use which threatens the extinction of traditional religions. For example, the *Okala nsin* of *Okerewa,* associated with an inland body of water, is no longer in existence due to development. Similarly, *Otalloboni,* in Akpajo, has been relocated for its safe keeping from development within the area. Photographs or exact locations of sacred areas are often not permitted for reasons of cultural safeguarding.

The traditional New Yam festival takes place during and after harvest from September to October. During which time, it is customary not to eat the harvests of yams until it is offered to the ancestors, whom the community believes made the harvest possible.

Recently though, the decline in yam production has led to a decrease in participation in the yam festival. This is due largely to recent urbanization and industrialisation of the land previously used for agriculture.[64] Issues such as this need to be considered within the context of this Project, and appropriate mitigation measures need to be applied following an impact assessment.

There is **high potential** for the Project AoI to contain Intangible cultural heritage resources, this is expanded upon within Key Baseline Findings.

4.7.6 Key Baseline Findings

The baseline study identified a total of **three** cultural heritage resources within the Project AoI, comprising no Designated cultural heritage resources and **three** non-designated resources within the Project AoI.

The cultural heritage resources were each assigned a unique identifier (for example MM_CH_001). Details of the intangible cultural heritage resource is provided below. Further details on each cultural heritage resource and related maps can be found in **Annexure 4.10**.

Designated Cultural Heritage

No designated cultural heritage resources were identified within the Project AoI.

[64] SIA, HIA Cultural heritage report for the IEFCL-Train3 Project ESIA. November 2021.

Non-designated cultural heritage

A total of **three** non-designated cultural heritage resources were identified within the Project AoI and are presented below:

- Shrines: After the Nigerian civil war in 1970, several shrines were utilised by the community to practice Traditional religion until Christianity became the dominant religion. **Three** shrines are still utilised today in the Ele and Owo-Ogono fishing settlements in Ogu as presented below:
  - MM_CH_001: shrine located within the Ele fishing settlement (Plate 4-6).
  - MM_CH_002: shrine and sacred location within the Owo-Ogono fishing community (Plate 4-7).
  - MM_CH_003: Shrine tree representing a sacred deity and the gods of Ele-Ogu (Plate 4-8)

Plate 4-6: MM_CH_001[65]

[65] Indorama, 2023

Plate 4-7: MM_CH_002[66]

Plate 4-8 MM_CH_003[67]

[66] Indorama, 2023
[67] Indorama, 2023

4.7.7 Summary of Key Cultural Heritage Sensitivities

The history of the area indicates the potential for further archaeological sites and buried remains to exist below the surface resulting in a risk of additional, previously unknown cultural heritage to be present within the Project AoI. No tangible cultural heritage resources were considered sensitive to the Project. The baseline results indicate that the 3 intangible cultural heritage resources identified (MM_CH_001, 002, and 003) can be replicated. There are thus no key cultural heritage sensitivities identified within the Project AoI.

4.8 Traffic

4.8.1.1 Road Infrastructure

Major roads that will be used by the Project include:

- **East West Highway**: This arterial (also referred to as the East West Expressway or Road) connects southeastern Nigeria to Port Harcourt, and has an interchange with the A3 road, a national north-south highway, in Port Harcourt. In the vicinity of the New Road Junction to Onne Road (where the East West Highway would intersect a new access road the Indorama complex), the East-West Highway is a paved (asphalt) four-lane road with two travel lanes in each direction, approximate paved width of 24m, an intermittent low jersey barrier median, no drainage or sidewalks, and unpaved shoulders. The pavement condition is degraded.
- **Federal Ocean Terminal (FOT) Roadway**: The FOT Roadway (also referred to as the Nigeria Ports Authority [NPA] Dual Carriageway) is an asphalt-paved, divided road with a paved width of about 8m in each direction, a 5m wide landscaped median with curbs, and intermittent unpaved shoulders. Although wide enough for multiple lanes, each direction of the road typically accommodates one lane of traffic, along with vehicles parked along the edge of the roadway.
- **Onne Road**: Onne Road connects the FOT roadway to East-West Road. Onne Road is an asphalt-paved, divided road with an unmarked paved width of about 8m in each direction, a 2m concrete median, and intermittent unpaved shoulders. The road could accommodate two travel lanes but typically accommodates one lane of traffic, primarily truck traffic, with vehicles parked along the roadway edges. Onne Road also has parallel service roads on either side of the main roadway. The service roads are 4 to5 meters wide with asphalt paving, separated from the main roadway by a curbed, grass median about 0.5m wide. Residences, businesses, market stalls and local roads have direct access to the service roads, while the median prohibits access to the centre roadway lanes. Access to the centre lanes is provided at three major intersections by traffic circles.
- **Local Road Networks** that intersect the larger roadways are generally paved but narrower in width. Some include walkways and drainage, but shoulders are not typically present.

4.8.1.2 Port Infrastructure

The Nigerian Ports Authority regulates all major ports in the country, including the Port of Onne (WPS, 2023). The Onne Port is an industrial port on the Bonny River estuary south of Port Harcourt in south-eastern Nigeria that covers an area of approximately 2,538 hectares. Onne Port accounts for over 65% of all cargo exported from Nigeria (NPA 2023). It serves oil and gas operations and equipment, as well as general, bulk (dry and wet), and container cargo, and other logistics services. The port is highly industrialized with modern facilities and equipment. The port has some of the largest mobile harbour cranes in Africa (NPA, 2023).

Onne Port is also one of the largest Oil and Gas Free Zones in the world and provides facilities supporting onshore and offshore oil and gas activities in Nigeria, as well as providing water access for products from West African and Sub-Saharan oil fields.

4.8.2 Existing Traffic Data

4.8.2.1 Road Traffic

A traffic survey of the Study Area was conducted from 7 to 13 July 2023 by MM FZE's local consultant ECSL. The traffic survey was conducted manually at seven locations over a 14-hour time period (06:00h to 20:00h). Figure 4-54 identifies the seven traffic count locations where data (including information on traffic origin and destination) were recorded. These locations include:

- TC1: East-West Highway at New Road Junction;
- TC2: Onne Road, First Roundabout near Onne Health Centre;
- TC3: Onne Road, Second Roundabout near NAFCON Junction;
- TC4: FOT Road at NPA Main Entrance Gate;
- TC5: West Africa Container Terminal (WACT)/Onne Multipurpose Terminal (OMT) Entrance Off FOT Road;
- TC6: New WACT/OMT Road under construction; and
- TC7: New WACT/OMT Road to Project site.

Due to low traffic volumes, traffic at locations TC6 and TC 7 (locations adjacent to the proposed Project) are not evaluated in this report.

Traffic was grouped into four vehicle categories:

- Category 1: Motorcycles/Tricycles;
- Category 2: Cars and Light Vans;
- Category 3: Medium and Heavy Goods Vehicles (Lorries and Trucks); and
- Category 4: Buses and Coaches.

Source: Indorama 2023

Figure 4-54: Location of Traffic Data Surveys.

Table 4-423 summarizes daytime traffic volumes at the count locations, whereas detailed survey data presented in **Annexure 4.11**. The highest levels of traffic occurred along the East West Highway at the New Road Junction (TC 1). The highest traffic volumes at this location occurred on Wednesday and the lowest on Friday. Amongst the other road locations surveyed, specific days of highest traffic volumes varied, while Sunday had the lowest daily traffic. Hours of peak traffic and lowest traffic varied. The sections below summarise traffic data trends and observations for each traffic data survey location.

Table 4-43: Summary of Average Daytime Traffic Volumes (July 13-19, 2023, 06:00 to 20:00h).

Category	TC1		TC2		TC3		TC4		TC5	
	WB	EB	SB	NB	SB	NB	SB	NB	SB	NB
1 (Motorcycle/Keke)	3,002	2,953	2,364	2,501	2,170	3,814	148	276	146	136
2 (Car and Light Vans)	5,337	3,916	1,957	1,934	1,797	2,044	1,919	1,529	658	598
3 (Lorries and Trucks)	1,224	1,101	1,124	1,135	905	602	712	558	163	308
4 (Buses and Coaches)	453	421	537	640	206	173	162	151	55	45
Total	**10,016**	**8,392**	**5,982**	**6,210**	**5,078**	**6,633**	**2,941**	**2,515**	**1,021**	**1,087**

Source: Indorama 2023

TC 1 East-West Highway by New Road Junction

Traffic volumes on the East West Highway by New Road Junction were by far the largest of the traffic count locations, varying from a high of 23,145 vehicles on Wednesday to a low of 14,422 vehicles on Friday. The average hourly traffic ranged from 514 vehicles to 1,415 vehicles for westbound traffic (towards Port Harcourt) and from 477 to 791 vehicles for eastbound traffic (towards Eleme). Peak hourly traffic occurred between 08:00 and 09:00 for westbound traffic and between 06:00 and 07:00 for eastbound traffic. Vehicles on the East West Highway consisted of 32.3% motorcycles/keke (category 1), 50.3% cars/light vans (category 2), 12.6% trucks/lorries (category 3) and 4.8% buses/coaches (category 4).

TC2: Onne Road, First Roundabout near Onne Health Centre

Traffic at this location was highest on Saturday with a total of 19,565 vehicles, with 9,352 traveling southbound and 10,213 traveling northbound. The lowest traffic volume occurred on Sunday with a total of 6,205 vehicles. The average hourly traffic volumes ranged from 383 to 503 vehicles southbound and 414 to 554 vehicles northbound. Peak traffic hours occurred from 14:00 to 15:00 for southbound and 15:00 to 16:00 for northbound. Vehicle types consisted of 39.9% category 1, 31.9% category 2, 18.5% category 3, and 9.7% category 4.

TC3: Onne Road, Second Roundabout near NAFCON Junction

Traffic volumes at this location were highest on Thursday with a total of 13,546 vehicles with 6,648 traveling southbound and 6,898 traveling northbound. Sunday had the lowest traffic volume at 9,658. The average hourly traffic volume ranged from 212 to 585 vehicles traveling southbound. Northbound average hourly traffic ranged from 439 to 585. Peak traffic hours occurred from 10:00 to 11:00 for southbound and 15:00 to 16:00 for northbound. Vehicle types consisted of 51.1% category 1, 32.8% category 2, 12.9% category 3, and 3.2% category 4.

TC4: FOT Road at NPA Main Entrance Gate

Traffic volumes at this location were highest on Friday with a total of 6,955 vehicles with 3,415 traveling southbound and 3,540 traveling northbound. Sunday had the lowest traffic volume at 2,661. The average hourly traffic volumes ranged from 166 to 320 vehicles southbound and 117 to 345 vehicles northbound. Peak traffic hours occurred from 11:00 to 12:00 for southbound and 16:00 to 17:00 for northbound. Vehicle types on the FOT road include a lower proportion of motorcycles and higher proportion of trucks as compared to the Onne Road or East West Highway, and consisted of 7.8% category 1, 63.2% category 2, 23.3% category 3, and 5.7% category 4.

TC5: WACT/Onne Multipurpose Terminal (OMT) Entrance Off FOT Road

Traffic volumes at this location were highest on Monday with a total of 2,818 vehicles with 1,371 traveling southbound and 1,447 traveling northbound. Sunday had the lowest traffic volume at 724. The average hourly traffic volumes ranged from 67 to 103 vehicles southbound and 61 to 109 vehicles northbound. Peak traffic hours occurred from 07:00 to 08:00 for southbound and 14:00 to 15:00 for northbound. Vehicle types consisted of 13.3% category 1, 59.6% category 2, 22.4% category 3, and 4.7% category 4.

4.8.2.2 Vessel Traffic

According to the Nigerian Port Authority, Nigerian ports handled 4,100 vessels and more than125 million gross tons of cargo in 2021, compared to an annual average of 4,400 vessels and 116 million tons between 2011 and 2021 (NPA 2022). The Port of Onne handled 643 vessels in 2021. Table 4-434 identifies the number of vessels per terminal berth or jetty at the Port of Onne in 2021 and 2022, including the FOT and the Federal Lighter Terminal (FLT), the two largest terminals within the port.

Table 4-44: Vessel Traffic at Port of Onne in 2021 and 2022

Terminal	Total 2022	Total 2021
FLT A (BRAWAL)	25	31
FLT B (INTELS)	13	20
FOT A (INTELS)	35	51
FOT B (WACT)	93	110
FOT-OMT	77	44
OIS Indorama Jetty	47	28
Dangote Jetty	0	7
Notore Jetty	4	2
Bonny Terminal	307	350
Total	**601**	**643**

Source: NPA Onne Office

The Bonny Terminal received more than half of the vessel traffic for the Port of Onne in 2021 and 2022. Although the Bonny Terminal is associated with the Port of Onne, it is located approximately 40 km downstream on the Bonny River, on Ogu Creek near the mouth of the Atlantic Ocean. Table 4-445 displays the 2023 Port of Onne vessel traffic as of June 2023. Vessel traffic in Onne Port has averaged 49 vessels per month which is similar to the 2022 average of 50 vessels per month.

Table 4-45: Vessel Traffic at Port of Onne in the first half of 2023.

Terminal	January	February	March	April	May	June
FLT A (BRAWAL)	0	2	0	0	2	1
FLT B (INTELS)	1	0	1	0	0	1
FOT A (INTELS)	1	4	7	1	4	4
FOT B (WACT)	8	9	9	7	7	11
FOT-OMT	7	7	9	6	7	7

Terminal	January	February	March	April	May	June
OIS Indorama Jetty	4	3	6	6	5	1
Dangote Jetty	0	0	0	0	0	0
Notore Jetty	0	0	0	0	0	1
Bonny Terminal	21	23	24	26	22	26
Total	**42**	**48**	**56**	**46**	**47**	**53**

Source: NPA Onne office

4.8.3 Road Safety

Nigeria reported 5,053 traffic fatalities in 2016, although the World Health Organization (WHO) estimated a significantly larger number. The WHO estimated that Nigeria experiences 21.4 fatalities per 100,000 populations in 2016, equivalent to nearly 40,000 traffic fatalities per year (WHO 2018). This rate was lower than the Africa-wide estimate of 27.6 fatalities per 100,000 populations (World Bank 2019). Nigeria has established numerous regulations to increase road safety, including road design standards, seat belts and motorcycle helmets requirements, a ban on hand-held mobile phone use, blood alcohol limits and speed limits. WHO ranks Nigeria's traffic regulation enforcement at 3 to 9 on a scale of 1 to 10 (with 10 representing the most rigorous enforcement).

The 2023 traffic survey report compiled for the Project identified safety issues of concern on Project-area roads, including increased vehicular accidents and risks to pedestrians trying to cross the FOT Road at the Main Entrance Gate (TC4) due to the presence of trucks parked on the through and service lanes of the FOT Road. These concerns notwithstanding, reported accident rates were relatively low along the FOT Road, which Indorama has been attributed to "regular sensitization of motorists and pedestrians by Port Authorities and other social groups".

4.8.4 Vessel Safety

On Nigerian rivers, human factors such as collision, overloading, and speed were the primary cause of approximately 67% of marine casualty events (the standard term for incidents involving vessels) from 2010 to 2021. Between 1989 and 2018, there were 98 vessel incidents resulting in fatalities on the Bonny River between Port Harcourt and the Atlantic Ocean These incidents represented approximately 13.5%of fatal riverine accidents in Rivers State and 3.5%t of combined fatal riverine accidents in Lagos, Rivers, and Cross River States (the three states in Nigeria with substantial river-based transportation routes) (Ogboeli et al., 2023).

4.8.5 Summary of Key Traffic Sensitivities

- Existing levels of congestion on the East West Highway, which connects south-eastern Nigeria to Port Harcourt, are anticipated to increase due to increases in peak hour traffic, large vehicle traffic, and turning movements at the New Road Junction and Onne Road resulting from the Indorama Train 3 project and this Project.
- Congestion on the route from the Port of Onne to the East West Road may increase due to increased truck traffic.
- Project-related vessel traffic will incrementally increase vessel congestion and risk of marine casualty events on the Bonny River.

4.9 Stakeholder Engagement

4.9.1 Introduction

This Section summarises stakeholder engagement undertaken thus far for the Project ESIA process. All engagement activities have been undertaken by MM FZE's in-country consultant, ECSL, the outcomes of which are included in the Stakeholder Engagement report dated 17 August 2023. Reference should be made to this document for a full context of all engagement activities undertaken thus far, including meeting minutes and attendance registers.

4.9.2 Objectives and Principles of Stakeholder Engagement

The following objectives relate to the stakeholder engagement component of the ESIA process:

- Understand the interests, influence, and concerns of various Project stakeholders;
- Ensure effective, transparent, and timely communication between the Project and its stakeholders, to engender an environment of trust and mutual respect;
- Engage stakeholders on their concerns regarding the Project, and appropriately address these through dialogue and corrective actions;
- Establish effective means of communication to disseminate information from the Project to stakeholders;
- Design stakeholder engagement mechanisms and standards that respect local traditions and cultural norms; and
- Effectively manage the expectations of stakeholders regarding socio-economic benefits derived from the Project.

The key principles guiding the Project's approach to stakeholder engagement are as follows:

- **Transparency:** to be open and transparent with stakeholders;
- **Accountability:** to be willing to accept responsibility as a corporate citizen and to account for impacts associated with the Project activities;
- **Trust:** to have a relationship with stakeholders that is based on mutual commitment to acting in good faith;
- **Mutual Respect:** to respect stakeholders' interests, opinions and aspirations;
- **Collaboration:** to work cooperatively with stakeholders to find solutions that meet common interests;
- **Responsiveness:** to coherently respond in good time to stakeholders;
- **Proactiveness:** to act in anticipation of the need for information or potential issues;

- **Fairness:** to engage with stakeholders such that they feel they are treated fairly, and their issues and concerns are afforded fair consideration;
- **Accessibility:** to be within reach of stakeholders so that they feel heard and to provide meaningful information as needed; and
- **Inclusivity:** to proactively anticipate, identify and include all stakeholders.

4.9.3 Identification of Stakeholders

To undertake effective engagement, it is necessary to identify Project stakeholders and understand their interest, priorities, and objectives in relation to the Project. For the purposes of this ESIA, a stakeholder is defined as any individual or group who is potentially affected by the Project, or who has an interest in the Project and its potential impacts. Table 4-456 presents the stakeholders currently identified for the Project.

Table 4-46: Stakeholder Engagements

Stakeholder Category	Stakeholder Groups	Stakeholders	Connection to Project
Government	• Federal Ministry of Environment • Rivers State Ministry of Environment • Nigerian Ports Authority • Rivers State Ministry of Chieftaincy and Community Affairs • Eleme Local Government • Ogu-Bolo Local Government	• Director, Environment Assessment Department, Federal Ministry of Environment • Director, Pollution Control & Environment Health Department, Federal Ministry of Environment • Rivers State Commissioner of Ministry of Environment • Director, Pollution Control Department, Rivers State Ministry of Environment • Director, Environment Assessment Department, Rivers State Ministry of Environment • Rivers State Commissioner of Chieftaincy & Community Affairs • Supervisor to Environment, Eleme Local Government • Supervisor to Environment, Ogu-Bolo Local Government	Environmental Regulatory bodies are of primary importance in terms of establishing policy, granting permits or other approvals for the Project, and monitoring and enforcing compliance with Nigerian law throughout all stages of the Project life cycle. Regional and Local Governments may input into the permitting process and may have a role in monitoring the implementation of Project commitments included in the ESMP.
Traditional Rulers and Community Leaders	• Onne Traditional Leaders • Ogu Traditional Leaders • Clan Heads • Community Development Committees	• Paramount Ruler of Onne • Paramount Ruler of Ogu	Local community leaders as representatives of their local community.

Stakeholder Category	Stakeholder Groups	Stakeholders	Connection to Project
			Traditional rulers play vital roles in community development, civil administration, and socio-economic wellbeing in their domain by interfacing with the government. Traditional rulers are custodians of cultures, customary territorial rights, and privileges of people in their communities. Traditional rulers preside over civil and customary grievance / dispute resolution processes. Traditional rulers represent and protect the socio–economic interest of the communities before government and external agencies. Traditional rulers participate in Public Forum discussions and Technical Panel review as part of ESIA. Traditional rulers' interface with Indorama for community development projects (CSR). Management of communication in the communities with respect to project.
Directly Impacted Communities	• Communities within close proximity of the proposed port facility	• Onne community • Ogu community • Community development committees	Oil & Gas Free Zone Area (OGFZA) was established by Section 2 of the Oil and Gas Export Free Zone Act No. 8 of 1996 to regulate Nigeria's Oil and Gas free trade zones. The Authority began operation in Onne, Rivers State in 2001. However, there will be social, environmental, and economic impacts connected to project construction and operation of Port Terminal facility.

Stakeholder Category	Stakeholder Groups	Stakeholders	Connection to Project
			Community Development Committees are entrusted with the responsibility to interface with the company on behalf of communities for the following: • Participation in ESIA Public forums to discuss positive / negative impacts of the project and the mitigation measures. • Participation in ESIA Technical Panel review to observe the evaluation process of mitigation measures set out to address the adverse impacts be social / economic / environmental impacts by experts and regulatory authorities. • Manage communications in the communities regarding the outcome of public forums and technical panel review. • Agreements and communiques • Monitoring implementation of agreements / communiques for the following: ○ Community Development Projects ○ Contracts and supplies ○ Employment during construction and operation phase. ○ Scholarship programmes for youth studying in universities. ○ Micro Grant for women for micro business ○ Skill development programme for young men and women.

Stakeholder Category	Stakeholder Groups	Stakeholders	Connection to Project
Vulnerable Groups	• Women • Youth	• Onne Women Leaders • Ogu Women Leaders • Onne Youth Council • Ogu Youth Council	Women representatives and youth representatives are going to be an integral part of the decision-making process during ESIA public forum, technical panel review, adverse impacts / mitigation measures, MOU, community development projects, employment, skill acquisition programme, subcontracts & supplies, and grievance management process during ESIA / construction / operation phase of the project.
Employment and Business Associations	• Workers Unions • Employment Forums • Contractors • Oil & Gas Free Zone Area (OGFZA) Joint Community Relations Committee	• Welders and Fitters Association • Indigenous Suppliers Forum • OGFZA – Joint Community Relations Committee	Elected representatives of unions participate in collective bargaining agreements for betterment of condition of service, discussion on betterment of working condition, grievance management process, disciplinary management process, conflict and dispute resolution process during the construction and operation phase of the project. Elected / nominated members of Indigenous Suppliers represent their members for access to information with regards to contracts, supplies, grievance management dispute / conflict resolutions. Joint Community Relations Committee is a representative forum. Members are nominated by companies who operate in OGFZE to discuss, resolve issues connected with communities and develop an overall CSR strategy.
Other stakeholders	• Academia • Media	• Professors / teachers • Radio and Print media	Linkage between theory and practical through industrial training, new skill development and recruitment and funding for research and development. Information from source via direct meeting or site visit, coverage of CSR events via invitation to events

4.9.4 Approach to Stakeholder Engagement

The Nigerian EIA Act, No. 86 of 1992 requires that an EIA[68] is undertaken for all public and private development projects. The Act divides projects into three categories:

- Category 1 projects that require a full and mandatory EIA;
- Category 2 projects that require a partial EIA; and
- Category 3 projects that are deemed as beneficial to the environment and therefore require no EIA.

It should be noted that the Federal Ministry of Environment (FMEnv) classified the port expansion Project as a Category 1 Project.

According to the EIA regulations, "Public Participation should be seen as a continuous programme for the environmental and economic sustainability of the project." Public entry points into the EIA process are contained in four distinct stages of the EIA:

1. A scoping workshop is required during the scoping phase, especially if public interest in the project is high, and is required to include key stakeholders.
2. Stakeholders are required to be involved in the EIA drafting process, where "proceedings of consultations with adjoining communities and other stakeholders held in a Public Forum (Public Participation)" are to be submitted with the draft EIA. This includes surveys which may be conducted to determine the social baseline and capture stakeholder comments on the project.
3. During the review of the EIA, it may be required that EIA documents are disclosed publicly for 21 days. Disclosure points should include, at a minimum, the Local Government Area offices, the state Environmental Protection Agency Offices, and the FMEnv Headquarters. Other disclosure locations should be considered as appropriate. Project-affected communities should be invited to participate in the review process through newspaper advertisements and radio announcements.
4. If the project is classified as Category 1, the public is invited to comment on the project during a public hearing/panel review.

4.9.5 Summary of Previous Engagement

The stakeholder engagements undertaken in support of the ESIA process by ECSL are presented in Table 4-467 below, while the full engagement proceedings are presented in **Annexure 4.12.**

[68] Nigerian regulations refer only to an Environmental Impact Assessment, or EIA. Given that the impact assessment conducted for the Project has been aligned to the IFC Performance Standards, the assessment documents are referred to as an Environmental and Social Impact Assessment (ESIA) in the remainder of this plan to better reflect the contents of the impact assessment.

Table 4-47: Previous Stakeholder Engagements.

Date	Stakeholder	Number of attendees	Purpose
8 December 2022	FMEnv – EA Dept, Team leaders	7	Discuss proposed Project and draft ToR (Institutional Consultation)
17 January 2023	FMEnv, Rivers State Ministry of Environment (RSMEnv), ECSL & Proponent reps	12	Site verification required for Project categorization (Institutional Consultation)
12 April 2023	FMEnv, RSMEnv, Eleme LGA, Relevant Stakeholders, ECSL & Proponent reps	47	Scoping workshop with Onne Community for ESIA, ToR/SoW (Institutional and Public Participation)
13 April 2023	FMEnv, RSMEnv, Ogu-Bolo LGA, Relevant Stakeholders, ECSL & Proponent reps	36	Scoping workshop with Ogu Community for ESIA, ToR/SoW (Institutional and Public Participation)
4 July 2023	FMEnv, RSMEnv, ECSL Team Proponent & Community reps	22	Kick-off meeting for field data gathering exercise to streamline sampling strategy and techniques
11 July 2023	Ogu community stakeholders - Community Chiefs, CDC, Women Leader and Executive, Community Youth President and Executive, Farmers, Traders etc.	20	Educate participants on the proposed Project scope, environmental, social, economic and health aspects. Possible impacts of the project and community perspective (expectation, benefits, and perception etc.).
12 July 2023	Onne community stakeholders - Community Chiefs, CDC, Women Leader and Executive, Community Youth President and Executive, Farmers, Traders etc.	20	Educate participants on the proposed Project scope, environmental, social, economic and health aspects. Possible impacts of the project and community perspective (expectation, benefits, and perception etc.).

4.9.6 Existing Stakeholder Concerns

The following high-level stakeholder concerns have been captured based on those engagements undertaken for the Project to date:

- Loss of Land: Deterioration and destruction of natural land and trees/plants for the development of the Project;
- Environmental Impacts: Negative impacts on the natural environment and biodiversity such as groundwater, surface water, and air pollution;
- Socioeconomic Benefits: Potential for unequal distribution of employment, procurement, and corporate social investment benefits between communities, and a perceived insufficiency of such interventions given the scale of need in the area;

- Traffic: Increased traffic levels traversing through Onne as well as the safety impacts on informal traders; and
- Ongoing Engagement: A perceived lack of sufficient ongoing engagement between Indorama and host communities.

4.9.7 ESIA Engagement

This *Section* summarises ESIA engagements which have thus far been completed, as well as those which remain outstanding as presented in Table 4-478 below:

Table 4-48: Completed and Planned ESIA Engagements

Engagement Requirement	Description	Status
Public Involvement in Scoping Workshop	As per Nigerian environmental regulations, a public hearing may be requested during the scoping phase to adequately determine the Terms of Reference of the ESIA.	Complete
ESIA Disclosure	Following the completion of the ESIA, findings should be disclosed to all stakeholders. In compliance with the EIA Act, CAP E12 LFN 2004 once the ESIA is under review by FMEnv the ESIA documents may be requested to be disclosed publicly for 21 days. Locations to display the documents should include: ▪ Eleme Local Government Area offices; ▪ Ogu-Bolo Local Government Area offices; ▪ Rivers State Ministry of Environment Offices; and ▪ The Federal Ministry of Environment Zonal and Headquarters.	To be completed following finalisation of ESIA process
ESIA Comment and Objection	Indorama must make reasonable opportunity available to stakeholders to comment or object to the ESIA findings. This will be conducted in compliance with EIA Act, CAP E12 LFN 2004 and will include advertisements in local newspapers to invite the public to participate in the ESIA review process, where necessary. Where the comments or objections are deemed reasonable and eligible, Indorama will endeavour to address them through an updated Project design or through further engagement with the objecting stakeholders.	To be completed following finalisation of ESIA process

4.9.8 Post-ESIA Engagement

Following the finalisation of the ESIA process, Indorama's engagement with stakeholders will be managed through a shared stakeholder engagement plan (SEP) between the Train 3 fertiliser plant expansion project, as well as the Project. However, a dedicated stakeholder engagement plan (SEP) for the project is developed which is annexed with this report as **Appendix B.**

CHAPTER – FIVE

5 ASSOCIATED AND POTENTIAL ENVIRONMENTAL IMPACTS

5.1 Impacts Assessment and Mitigation Methodology

5.1.1 Introduction

This impact assessment stage comprises a number of steps that collectively assess the manner in which the Project will interact with elements of the physical, biological, cultural, or human environment to produce impacts to resources/receptors. The steps involved in the impact assessment stage are described in greater detail below.

NOTE:

The impact assessment process detailed below is an approach that combines *Impact Magnitude* and *Receptor Sensitivity* to determine **Impact Significance** (refer to methodology included in *Section 5.1.2*). For determination of air quality and noise impacts however, one can usually predict emission levels quantitatively and compare them against Impact Assessment Standards that consider Receptor Sensitivity and/ or the source of noise or air contaminants to develop suitable criteria. For example, the World Bank Gorup (WBG) Environmental Health and Safety (EHS) Guidelines Standards set different noise levels for industrial areas than for residences. Other standards can be more prescriptive, offering numerical guidance to determine criteria and assessment of impacts, and can also be source specific. For example, industrial noise is different to road traffic noise, rail traffic and aircraft noise. Thus, the impact assessment process for air quality and noise will be different to that detailed in Section 5.1.2 to below. The air quality and noise impact assessment methodologies are detailed in Section 5.5.3 and Section 5.1.4 respectively.

Furthermore, the significance of potential key climate-related risks on the Project have been determined through a high-level scenario analysis, which has assessed the impact of climate change on physical climate-related risks associated with a full list of hazard types assessed to be applicable to the Project. The climate change assessment methodology is detailed in Section 5.1.5.

5.1.2 Impact Assessment

5.1.2.1 Impact Prediction

5.1.2.1.1 Introduction

The impact assessment process predicts and describes impacts that are expected to occur for different phases of the Project. Where possible, impacts are quantified to the extent practicable, which may include hectares of land affected; increase in noise or air pollution levels above acceptable standards; volume of waste or water discharged, number of graves affected, etc.

For each impact, its significance is evaluated by defining and evaluating two key aspects:

- The **magnitude** of the impact, and
- The **sensitivity** of the feature or receptor that will be impacted.

5.1.2.1.2 Impact Magnitude

Magnitude essentially describes the intensity of the change that is predicted to occur in the resource/receptor as a result of the impact. A magnitude rating tends to reflect a combination of the size of an area that may be affected, the duration over which the aspect may be altered, and the size, degree or scale of that change. In essence, magnitude is a descriptor for the degree of change that is predicted to occur in the resource or receptor.

For positive impacts (which are mostly socio-economic impacts) magnitude is generally categorised as 'Positive' unless sufficient information is available to support a more robust characterisation and to assign the degree of magnitude as Small, Medium, or Large. For instance, if the number of jobs to be assigned to local community members is confirmed or if the size or value of the contribution to the national, regional or district economy is known then a magnitude rating can be assigned. If not, then the significance rating is assigned based on the sensitivity of the feature impacted by a specific activity or change.

The term '**magnitude**' therefore encompasses all the characteristics of the predicted impact including:

- Extent;
- Duration;
- Scale;
- Frequency; and
- Likelihood (only used for unplanned events).

The definitions for characteristics of magnitude used during the impact assessment are summarised in Table 5-1.

Table 5-1 Impact Characteristic Terminology

Characteristic	Definition	Designations
Type	A descriptor indicating the relationship of the impact to the Project (in terms of cause and effect).	Direct Indirect Induced
Extent	The "reach" of the impact (e.g., confined to a small area around the Project Footprint, projected for several kilometres, etc.).	Local Regional International
Duration	The time period over which a resource / receptor is affected.	Temporary Short-term Long-term Permanent

Characteristic	Definition	Designations
Scale	The size of the impact (e.g., the size of the area damaged or impacted, the fraction of a resource that is lost or affected, etc.).	[no fixed designations; intended to be a numerical value]
Frequency	A measure of the constancy or periodicity of the impact.	[no fixed designations; intended to be a numerical value]

The evaluation of pre-mitigation impact significance takes into account control measures that are already part of or embedded within the Project design. This avoids the situation where an impact is assigned a magnitude based on a hypothetical version of the Project that considers none of the embedded controls that are defined as part of the Project description. Examples of embedded controls could include acoustic reduction measures around noisy equipment or servitude and buffer requirements the development is obliged to implement and is part of the layout. Additional mitigation measures aimed at further reducing the significance of impacts are proposed where necessary or appropriate and are assessed as part of the 'residual' impact significance rating.

In the case of type, the designations are defined universally (i.e., the same definitions apply to all resources/receptors and associated impacts). For these universally defined designations, the definitions are provided in Table 5-2.

Table 5-2 Designation Definitions

Designation	Definition
Type	
Direct	Impacts that result from a direct interaction between the Project and a resource/receptor (e.g., between occupation of a plot of land and the habitats which are affected).
Indirect	Impacts that follow on from the direct interactions between the Project and its environment as a result of subsequent interactions within the environment (e.g., viability of a species population resulting from loss of part of a habitat as a result of the Project occupying a plot of land).
Induced	Impacts that result from other activities (which are not part of the Project) that happen as a consequence of

Designation	Definition
	the Project (e.g., influx of camp followers resulting from the importation of a large Project workforce).
Extent	
Local	Impacts that affect an area in proximity to the development area within an area defined on a resource/receptor-specific basis.
Regional	Impacts occurring at a regional scale as determined by administrative boundaries or which affect regionally important resources or ecosystems.
International	Impacts that extend across international boundaries or affect resources such as features, resources or areas protected by international conventions.
Duration	
Temporary	Impacts are predicted to be of short duration (in the order of days) and/or intermittent/occasional.
Short-term	Impacts that are predicted to last only for the duration of the construction period (i.e. – 8 years).
Medium-term	Impacts that will continue for a period of 5 to 10 years following the completion of the construction phase e.g., where the impact may reverse or affected resources or receptors recover within this period of time.
Long-term	Impacts that will continue for the life of the Project but will either cease when the Project stops operating or is decommissioned, or where the impact may reverse, or the affected resource / receptor recovers or reverts to a near-natural state after 10 or within 20 years following the completion of the construction phase.
Permanent	Impacts that cause a permanent change in the affected receptor or resource (e.g., removal or destruction of ecological habitat) that endures substantially beyond 20 years following the completion of the construction phase.

In the case of ***scale*** and ***frequency***, these characteristics are not assigned fixed designations, as they are typically numerical measurements (e.g., number of acres affected, number of times per day, etc.).

The terminology and designations are provided to ensure consistency when these characteristics are described in an impact assessment deliverable. However, it is not a requirement that each of these characteristics be discussed for every impact identified.

For unplanned events (e.g., accidental release of hazardous materials) the ***likelihood*** of the impact occurring is taken into consideration in deriving the magnitude rating. The likelihood of an impact occurring as a result of an unplanned event is expressed as a probability and is designated using a qualitative scale (or semi-quantitative, where appropriate data are available), according to the attributes described in Table 5-3.

Table 5-3 Definitions for Likelihood Designations (only used for unplanned events)

Likelihood	Definition
Unlikely	The event is unlikely but may occur at some time during normal operating conditions.
Possible	The event is likely to occur at some time during normal operating conditions.
Likely	The event will occur during normal operating conditions (i.e., it is essentially inevitable).

Likelihood is estimated on the basis of experience and/or evidence that such an outcome has previously occurred.

It is important to note that likelihood is a measure of the degree to which the unplanned event is expected to occur, *not* the degree to which an impact or effect is expected to occur as a result of the unplanned event. The latter concept is referred to as *uncertainty*, and this is typically dealt with in a contextual discussion in the impact assessment deliverable, rather than in the impact significance assignment process.

In the case of impacts resulting from unplanned events, the same resource/receptor-specific approach to concluding a magnitude designation is utilised, but the ‘likelihood’ factor is considered, together with the other impact characteristics, when assigning a magnitude designation. There is an inherent challenge in discussing impacts resulting from (planned) Project activities and those resulting from unplanned events. To avoid the need to fully elaborate on an impact resulting from an unplanned event prior to discussing what could be a very low likelihood of occurrence for the unplanned event, this methodology incorporates likelihood into the magnitude designation (i.e., in parallel with consideration of the other impact characteristics), so that the “likelihood-factored” magnitude can then be considered with the resource/receptor sensitivity/vulnerability/importance in order to assign impact significance. Rather than taking a prescriptive (e.g., matrix) approach to factoring likelihood into the magnitude designation process, it is recommended that this be done based on professional judgment, possibly assisted by quantitative data (e.g., modelling, frequency charts) where available.

Once the impact characteristics are understood, these characteristics are used (in a manner specific to the resource/receptor in question) to assign each impact a *magnitude*. In summary, magnitude is a function of the following impact characteristics:

- Extent;
- Duration;
- Scale;
- Frequency; and
- Likelihood.

Magnitude essentially describes the degree of change that the impact is likely to impart upon the resource/receptor. As in the case of extent and duration, the magnitude designations themselves (i.e., negligible, small, medium, large) are universally used and across resources/receptors, but the definitions for these designations will vary on a resource/receptor basis, as is discussed further below. The universal magnitude designations are:

- Positive;
- Negligible;
- Small;
- Medium; and
- Large.

The magnitude of impacts takes into account all the various dimensions of a particular impact in order to make a determination as to where the impact falls on the spectrum (in the case of adverse impacts) from *negligible* to *large*. Some impacts will result in changes to the environment that may be immeasurable, undetectable or within the range of normal natural variation. Such changes can be regarded as essentially having no impact and should be characterised as having a *negligible* magnitude.

5.1.2.2 Sensitivity

In addition to characterising the magnitude of impact, the other principal step necessary to assign significance for a given impact is to define the sensitivity/vulnerability /importance of the impacted resource/receptor to the type of activity proposed (e.g., habitat clearance, topsoil removal, etc.) or the consequences of a Project activity (e.g., dust, noise, water pollution, or induced population influx). This requires a range of physical, biological, cultural, or human factors to be taken into account and may also need to include other factors such as legal protection, government policy, stakeholder views and economic value.

Characterisation of sensitivity for a physical or biological resource or receptor (e.g., a water feature or parameter, cliff, vegetation type) will take into account its conservation status and importance (on a local, national and international scale), its vulnerability to disturbance, and its resilience to recover or withstand a specific impact or type of impact. Where the receptor is human or cultural, the value of that social and cultural heritage receptor/s and its vulnerability to the impact is considered, taking into account the receptor's resilience, including ability to adapt to change or use alternatives where available.

As in the case of magnitude, the sensitivity/vulnerability/importance designations themselves are universally consistent, but the definitions for these designations will vary on a resource/receptor basis. The universal sensitivity/vulnerability/importance designations are:

- Low;
- Medium; and
- High.

5.1.2.3 Evaluating Significance

Once magnitude of impact and sensitivity/vulnerability/importance of resource/receptor have been characterised, the significance of the impact is assigned using the impact significance matrix shown in Table 5-4.

For impacts resulting from unplanned events (typically accidents, such as a major oil spill or other event that cannot be reasonably foreseen), the above methodology is applied but likelihood is also considered when assigning the magnitude designation, as classified in Table 5-3.

Table 5-4 Impact Significances

Evaluation of Significance		**Sensitivity/Vulnerability/Importance of Resource/Receptor**		
		Low	**Medium**	**High**
Magnitude of Impact	**Negative Impacts**			
	Negligible	Negligible	Negligible	Minor
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	**Major**
	Large	Moderate	**Major**	**Critical**

The matrix applies universally to all resources/receptors, and all impacts to these resources/receptors, as the resource/receptor- or impact-specific considerations are factored into the assignment of magnitude and sensitivity designations that enter into the matrix. *Box* 5.1 provides a context for what the various impact significance ratings signify.

Box 5.1 Context of Impact Significances

An impact of ***Negligible*** significance is one where a resource/receptor (including people) will essentially not be affected in any way by a particular activity, or the predicted effect is deemed to be 'imperceptible' or is indistinguishable from natural background variations.

An impact of ***Minor*** significance is one where a resource/receptor will experience a noticeable effect, but the impact magnitude is sufficiently small (with or without mitigation) and/or the resource/receptor is of low sensitivity/ vulnerability/ importance. In either case, the magnitude should be well within applicable standards.

An impact of ***Moderate*** significance has an impact magnitude that is within applicable standards but falls somewhere in the range from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. Clearly, to design an activity so that its effects only just avoid breaking a law and/or cause a major impact is not best practice. The emphasis for moderate impacts is therefore on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that impacts of moderate significance have to be reduced to minor, but that moderate impacts are being managed effectively and efficiently.

An impact of ***Major*** significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. An aim of IA is to get to a position where the Project does not have any major residual impacts, certainly not ones that would endure into the long term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (i.e., ALARP has been applied). An example might be the visual impact of a facility. It is then the function of regulators and stakeholders to weigh such negative factors against the positive ones, such as employment, in coming to a decision on the Project.

An impact of ***Critical*** significance after all feasible mitigation measures have been identified and assessed warrants the highest level of attention and concern. As with residual impacts of major significance, the regulators and stakeholders will need to closely evaluate whether the positive impacts of the project outweigh residual negative impacts of critical significance. In many cases residual critical impacts can be considered as potential fatal flaw of the project.

5.1.2.4 Mitigation of Impacts

Once the significance of a given impact has been characterised using the above-mentioned methodologies, the next step is to evaluate what mitigation measures are warranted. In keeping with the Mitigation Hierarchy, the priority in mitigation is to first apply mitigation measures to the source of the impact (i.e., to avoid or reduce the magnitude of the impact from the associated project activity), and then to address the resultant effect to the resource/receptor via abatement or compensatory measures or offsets (i.e., to reduce the significance of the effect once all reasonably practicable mitigations have been applied to reduce the impact magnitude).

It is important to have a solid basis for recommending mitigation measures. The role of any given ESIA is to help develop a consentable project, and to help clients meet their business objectives in a responsible manner. Impact assessment is about identifying the aspects of a project that need to be managed and demonstrating how these have been appropriately dealt with. As key influencers in the decision-making process, the role of the impact assessment is not to stop development or propose every possible mitigation or compensatory measure imaginable, but rather to make balanced judgements as to what is warranted, informed by a high-quality evidence base.

Additional mitigation measures should not be declared for impacts rated as not significant unless the associated activity is related to conformance with an 'end of pipe' applicable requirement. Further, it is important to note that it is not an absolute necessity that all impacts be mitigated to a not significant level; rather the objective is to mitigate impacts to an as low as reasonably possible (ALARP) level.

As previously mentioned, embedded controls (i.e., physical or procedural controls that are planned as part of the project design and are not added in response to an impact significance assignment) are considered as part of the project (prior to entering the impact assessment stage of the impact assessment process).

5.1.2.5 Residual Impact Assessment

Once mitigation measures are declared, the next step in the impact assessment process is to assign residual impact significance. This is essentially a repeat of the impact assessment steps discussed above, considering the assumed implementation of the additional declared mitigation measures.

5.1.2.6 Cumulative Impacts/Effects

Cumulative impacts and effects are those that arise as a result of an impact and effect from the Project interacting with those from another activity to create an additional impact and effect. These are termed cumulative impacts and effects.

The approach for assessing cumulative impacts is influenced by the availability of information about the impact of the other activity, and whether it already exists or is only proposed. Cumulative impacts of the Project are identified and briefly described in a qualitative manner in the context of other existing or planned development Projects.

5.1.2.7 Dealing with Uncertainty

Even with a final design and an unchanging environment, impacts are difficult to predict with certainty. Uncertainty stemming from on-going development of the Project design is inevitable, and the environment is typically variable from season to season and year to year. Where such uncertainties are material to ESIA findings, they will be clearly stated and conservatively approached ('the precautionary approach') in order to identify the broadest range of likely residual impacts and necessary mitigation measures.

Potential impacts may be assessed using tools ranging from quantitative techniques such as mathematical modelling to qualitative techniques based on expert judgment and historical information. The accuracy of these assessment tools depends on the quality of the input data and available information. Where assumptions have been made, the nature of any uncertainties associated with the assumption is discussed. For qualitative predictions/assessments, some uncertainty is removed through consultation.

5.1.2.8 Management and Monitoring

Management and monitoring measures are defined in the ESMMP in order to identify whether:

- Impacts or their associated Project components remain in conformance with applicable standards or performance targets;
- Mitigation measures are effectively ameliorating impacts to the extent predicted or an acceptable level; and
- Additional mitigation or management measures or other investigations are required to further ameliorate project impacts.

The ESMMP identifies the designated responsibility for implementing mitigation measures, the performance targets to be achieved, and the assurance mechanisms and protocols required to verify the proper implementation of the mitigation measures.

5.1.3 Air Quality Impact Assessment

The Nigerian National Environmental (Air Quality Control) Regulations, 2021 were set out under section 34 of the National Environmental Standards and Relations Enforcement Agency (Establishment) Act, 2007, "*to improve control of the nation's air quality such an extent would enhance the protection of flora and fauna, human health and other resources affected by air quality deteriorations".* In the majority of cases, the WBG EHS Guidelines are substantially more stringent than the Nigerian Air Quality Standards; however, it is acknowledged that the IFC/World Health Organization (WHO) Global Air Quality Guidelines do not consider the economic factors affecting guideline attainment.

Within this assessment, both the relevant Nigerian and IFC PSs and WBG EHS Guidelines have been used.

MM FZE informed ERM that all that all material handling will be mitigated and have indicated that the controls in place will be sufficient to render residual impacts as negligible. As such, ERM propose to present a qualitative assessment[1] of material handling associated with the Project during the operational phase and set out the embedded mitigation. Given that the gas fired power generation plant will be <3MW, it is considered sufficiently small to be scoped out from detailed assessment and will not be considered in the impact assessment.

[1] ERM understands that MM FZE have verified that the Lenders associated with this Project are satisfied with a qualitative assessment of material handling associated with the Project during the operational phase.

The ammonia flare stack has been modelled to ensure that flare characteristics from an emergency event are sufficient to avoid significant impacts. The assessment uses dispersion modelling to identify the increase in air pollutants at ground level attributable to emissions. With due consideration of the baseline, the potential for future significant impacts is assessed.

For the modelling of the ammonia flare stack, ERM used the air dispersion modelling software called AERMOD, which is a steady-state plume dispersion model for simulating transport and dispersion from point, area, or volume sources based on an up-to-date characterisation of the atmospheric boundary layer. AERMOD fully incorporates the PRIME building downwash algorithms, advanced depositional parameters, local terrain and urban heat island effects, and advanced meteorological turbulence calculations. Moreover, ERM used the software AERMET to prepare meteorological data, which is required for modelling. AERMET uses standard meteorological measurements and surface parameters representative of the modelling domain to compute boundary layer parameters.

The flare characteristics are:

- Flare stack height: 30m
- Gas flow: 1000 kg/hr (1318m^3/hr, 0.393m^3/s)
- Flare diameter 0.254m
- Gas composition: 100% ammonia
- Conversion factor for NO_x to NO_2: 35% (1 hour mean)[2]

The flared ammonia gas will burn during an emergency and produce NO_x and NO_2.

The predicted change in ground level concentrations of pollutants from the Project is referred to as the 'Process Contribution' (PC).

To consider the significance of potential impacts, the existing baseline also needs to be taken into consideration. The sum of the PC and the existing baseline is described as the 'Predicted Environmental Concentration' (PEC).

The IFC differentiates the significance of impacts using a risk-based approach, which is based upon the existing baseline air quality in the vicinity of the project. The magnitude of the impact can therefore be defined on the basis of two functions:

- **Process Contribution (PC)**, this is the impact associated with emissions from the Project only; and
- **Predicted Environmental Concentration (PEC)**, this is the impact associated with PC added to the existing background conditions.

The significance of potential impacts, using both the PC and PEC, is assessed following WBG guidance as described below.

[2] IFC (2007) General EHS Guidance for Air Emissions and Ambient Air Quality, citing Frequently Asked Questions, Air Quality Modelling and Assessment Unit (AQMAU), UK Environment Agency

The WBG General EHS Guidelines state:

> *"Projects with significant sources of air emissions, and potential for significant impacts to ambient air quality, should prevent or minimize impacts by ensuring that:*
>
> *Emissions do not result in pollutant concentrations that reach or exceed relevant ambient quality guidelines and standards by applying national legislated standards, or in their absence, the current WHO Air Quality Guidelines, or other internationally recognized sources.*

and that:

> *Emissions do not contribute a significant portion to the attainment of relevant ambient air quality guidelines or standards. As a general rule, this Guideline suggests 25% of the applicable air quality standards to allow additional, future sustainable development in the same airshed [i.e., in an undegraded airshed]".*

In general, the '25% threshold' is being applied as a rule rather than a guideline.

The WBG also states that:

> *"An airshed should be considered as having poor air quality [degraded] if nationally legislated air quality standards or WHO Air Quality Guidelines are exceeded significantly".*

and:

> *"Facilities or projects located within poor quality airsheds, and within or next to areas established as ecologically sensitive (e.g., national parks), should ensure that any increase in pollution levels is as small as feasible, and amounts to a fraction of the applicable short-term and annual average air quality guidelines or standards as established in the project-specific environmental assessment."*

In general, the WBG guidelines are interpreted such that where air quality standards are exceeded, then the airshed is described as 'degraded'.

The criteria presented in Table 5-5 have been used in the Project ESIA to assess the significance of effects on sensitive human receptors. The process is in two stages:

- First stage to determine the **magnitude** of impacts of the PC as a percentage of the air quality standard or guideline; and
- Second stage, to determine the **significance** of effects in terms of the magnitude of impacts identified from the screening stage, considered alongside the PEC.

Table 5-5 Definition of Magnitude Criteria for Air Pollutants

Magnitude of impact	Un-degraded airshed (i.e. baseline < AQS)	Degraded airshed (i.e. baseline > AQS)
Negligible	PC <25% of AQS	PC <10% of AQS

Magnitude of impact	Un-degraded airshed (i.e. baseline < AQS)	Degraded airshed (i.e. baseline > AQS)
Small	PC between 25% and 50% of AQS and PEC <100% of AQS	PC between 10% and 30% of AQS
Medium	PC between 50% and 100% of AQS, and PEC <100% AQS; or	PC between 30% and 50% of AQS
	PC between 25% and 50% of AQS, and PEC >100% of AQS	
Large	PC > 100% of AQS; or	PC > 50% of AQS
	PC > 50% of AQS, and PEC >100% of AQS	

PC: Process Contribution
PEC: Predicted Environmental Concentration
AQS: Air Quality Standard

Classification as to whether a site or location is deemed to be undegraded or degraded (i.e., where ambient pollutant concentrations meet or exceed local or IFC/WBG standards, respectively), is generally ascertained through a review of local air quality monitoring data. It should be noted that an airshed can be classified as degraded for one pollutant and not for another, thus setting out different levels of criteria based on the potential significance of difference pollutant emissions.

When determining the level of significance, consideration of the sensitivity of receptors also needs to be given. In particular, there is growing evidence [3] that the elderly, children, and those with cardiovascular and/or respiratory disease are more susceptible to the harm from air pollution. The following sensitivity definitions have therefore been derived to take into account the potential receptor variability:

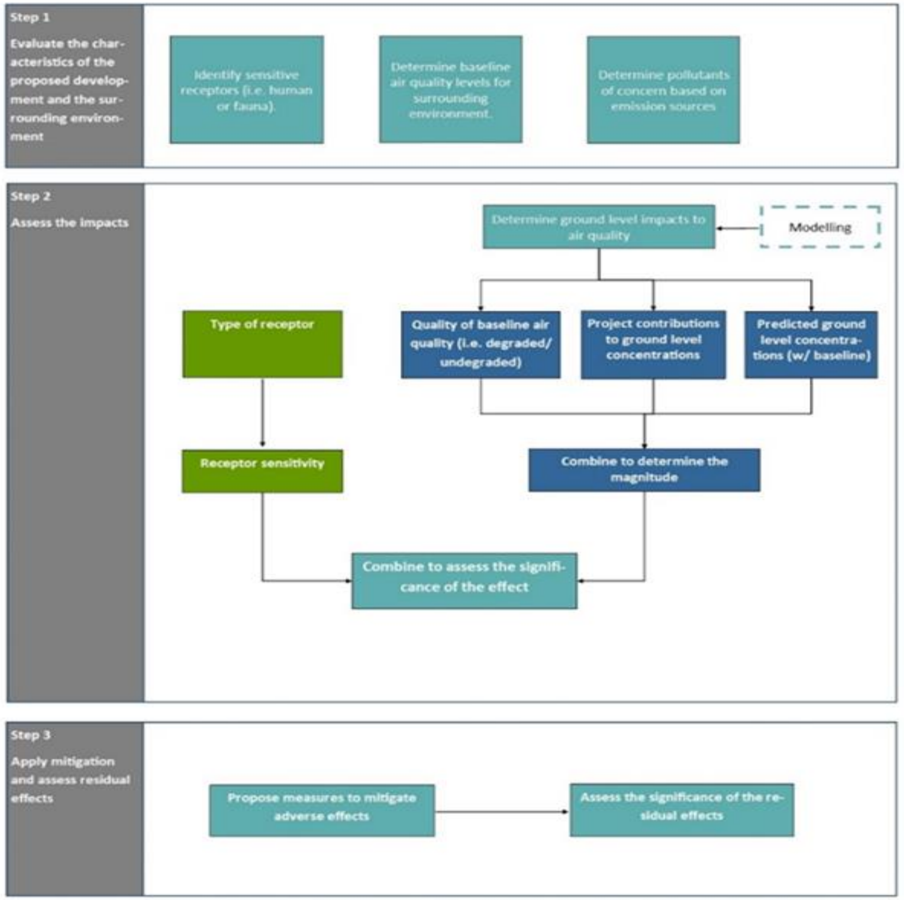
- **High Sensitivity**: locations where particularly vulnerable individuals (for example elderly, very young or infirm) are present, which include hospitals and schools.
- **Medium Sensitivity**: locations where the general population are present for large periods of the year, for example residential areas, towns, and villages.
- **Low Sensitivity**: locations where humans are transient or present for short periods only, such as agricultural areas or fishing areas.

The potential impact significance is therefore determined by considering both the magnitude of impacts and the receptor sensitivity.

The method for identifying significance of impacts of operational activities is set out in Figure 5-1.

(3) Defra & PHE (2017). Air Quality - A briefing for Directors of Public Health. Department for Environment, Food and Rural Affairs, and Public Health England, March 2017.

Figure 5-1 Assessment Methodology Operational Activities



Receptor Sensitivity

The sensitivity of ecological receptors is defined on the basis of their designated importance as an ecological resource. Any significant ecology impacts from air quality on non-designated sites will be assessed qualitatively as part of the Ecology assessment. This is typically determined on the basis of the statutory protection conferred on a receptor (for example, under the Ramsar convention). The table below provides receptor sensitivity with respects to human health. Sensitivity criteria for ecological receptors is as defined in the biodiversity methodology.

Sensitivity	Human	Ecology
Negligible	N/A	Non-designated habitats
Low	N/A	Locally designated sites
Medium	General population	Nationally designated sites
High	Particularly vulnerable individuals, e.g. a hospital with intensive care ward	Internationally designated sites

Magnitude of Change

The results of the air dispersion modelling are compared to the relevant air quality standards or guidelines (either for human health or ecology). Different standards/ guidelines will apply depending on the pollutant of concern and the averaging period. To determine magnitude, the Project's Contributions (PCs) to ground level pollutant concentrations are assessed in tandem with the total Predicted Environmental Contributions (PECs), where the PEC is the sum of the baseline concentration and the PC for a particular pollutant. The criteria used is presented below. Where national guidance exists for impact magnitude levels, this should take precedent to the value provided below.

PC as % of AQS	Magnitude
Undegraded Airsheds Where PEC < Air Quality Standards/Guidelines	
<10%	***Negligible***
10-25%	***Small***
25-75%	***Medium***
>75%	***Large***
Degraded Airsheds, i.e. Where PEC > Air Quality Standards/Guidelines	
<5%	***Negligible***
5-10%	***Small***
10-25%	***Medium***
>25%	***Large***

Note that in some countries a site-specific methodology is required to assess ecology impacts from air emissions (e.g. acid deposition and eutrophication). In such cases, an additional assessment would be required using site-specific ecology criteria.

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Assessing Air Quality Impacts from Industrial Sources

5.1.4 Noise Impact Assessment

Many numerical noise standards are noise source-specific (e.g., industrial noise is different from aircraft noise), some refer to baseline levels (i.e., allowable increases above baseline), and there can be a number of other factors that are relevant to determining Impact Significance.

Rather than applying a two-dimensional matrix for noise impact significance, the process for noise instead considers the type of receptor, draws on relevant standards or guidance to determine impact magnitude, and then considers other factors to determine significance.

5.1.4.1 Project Noise Criteria – Construction Phase

To evaluate the impact of temporary construction activities it is necessary to establish criteria above which significant adverse effects are likely be experienced. International best practice has been followed and thresholds above which a significant construction noise impact is considered to occur have been based on Nigerian criteria for construction (Table 5-6).

When assessing the significance of a noise impact, the process is slightly different to most other topics in this ESIA Report. The significance of an impact is derived from assessing the magnitude of the impact, but it also takes into consideration other factors like the duration of that specific construction activity, how well the infrastructure associated with the Noise Sensitive Receptors (NSR) can attenuate noise, etc.

Moreover, the sensitivity of the receptor is also considered in the assessment of impact magnitude. For example, NSRs sensitive to daytime noise are only assessed on the criteria associated with daytime activities, while those NSRs sensitive during the night-time are assessed using the criteria that consider the impact of noise on sleep disturbance.

For Project activities during the construction phase to create a significant noise impact, the noise generated must be above the noise impact threshold levels, as summarised in Table 5-6.

Table 5-6: Project Noise Criteria for Construction Phase.

Receptor	Maximum noise level permitted L_{Aeq} dB(A)	
	Day time	Night-time
Hospitals, schools, institutions of higher learning, homes for the disabled, etc.	**60**	50
Buildings other than those prescribed above	**75**	65

Construction activities will take place only during the daytime; therefore, the assessment of construction noise is based only on the daytime noise criteria (i.e. – those included in **bold** in Table 5-6).

The Project noise criteria used to assess the magnitude and significance of construction noise effects are included in **Table 5-7**.

Table 5-7: Magnitude and Significance of Construction Noise Effects.

Exceedance of criteria, dBA	Magnitude of predicted impact	Other relevant factors	Resulting Significance of effect
5 or more below the criteria	Negligible	Factors which may influence significance of effects, e.g., duration of construction activity	Negligible
> 5 below, up to the criteria	Small		Minor
Up to 5 dB above the criteria	Medium		Moderate
> 5 above the criteria	Large		Major

The classification of significance refers to Negligible, Minor, Moderate and Major. Impacts rated as Moderate or Major should be mitigated where practicable, feasible and reasonable with proportionately more emphasis on the Major items. Mitigation may not fully eliminate an impact but would be expected to reduce its severity.

5.1.4.2 Project Nosie Criteria – Operational Phase

For Project activities during the operational phase to create a significant noise impact, the noise generated must be above the noise impact threshold levels, as summarised in Table 5-8 and Table 5-9.

Table 5-8: Project Noise Criteria for Operational Phase at Receptors.

Receptor	One Hour L_{Aeq} (dB(A))	
	Daytime (06:01 – 22:00)	Night (22:01 – 06:00)
Residential; institutional; educational	55	45

The Project noise criteria used to assess the magnitude and significance of operational noise effects are included in Table 5-9. Existing noise baseline data are below the WBG absolute criteria for day and nighttime, and therefore the assessment for operational noise is based on the absolute WBG criteria for day and nighttime.

Table 5-9: Magnitude and Significance of Operational Noise Effects.

Exceedance of criteria, dBA	Magnitude of predicted impact	Other relevant factors	Resulting Significance of effect
> 5 below, up to the criteria	Negligible	Factors which may influence significance of effects, e.g., how well NSR infrastructure can attenuate noise	Negligible
Up to 5 dB above the criteria	Small		Minor
> 5 to 10 dB above the criteria	Medium		Moderate
> 10 dB above the criteria	Large		Major

5.1.4.3 Assessment of Potential Nosie Impacts

Given the fact that all noise sensitive receptors are located at distances greater than 1 km away from the Project boundary, ERM qualitatively assessed impacts from construction and operational activities. Moreover, a qualitative assessment was undertaken for underwater noise.

5.1.5 Climate Change Risk Assessment

5.1.5.1 Aim and Objectives

The aim of the Climate Change Risk Assessment (CCRA) is to assess the potential impact of climate change on the Project. This high-level CCRA considers the potential impact climate events may have on the Project during its construction and operational phases.

Therefore, the objectives of the CCRA are to:

- Review the potential existing extreme weather that may affect the Project;
- Undertake a high-level assessment of the way in which these physical hazards may become more intense and/or frequent as a result of climate change, and
- Identify the high-level climate-related risks and opportunities facing the Project over the construction and operational periods.

5.1.5.2 Context

Climate change, and the associated political and social response, is already presenting material risks and opportunities to business and industrial sectors. These risks and opportunities have grown in prominence over the last five to ten years and are expected to increase significantly in scale and coverage in the next decade.

The physical impacts of climate change pose a threat to business operations and may have financial consequences, through impacts of extreme weather events such as storms, floods, and droughts. The effect of these changes could result in business interruption through damage to physical assets. Understanding the nature of these risks will support sites in increasing their resilience against climate change.

5.1.5.3 Climate Scenarios

Scenarios are plausible descriptions of how the future may develop, based on a coherent and set of assumptions about driving forces, e.g., rate of greenhouse gas (GHG) emissions or changes in land use. They are not predictions nor forecasts. Scenario analysis is a useful approach for assessing the exposure of sites to climate-related risks and opportunities in an uncertain future world.

ERM utilises the latest climate projections data available from world-leading scientific organisations when assessing the impact of climate change on physical climate hazards for any given location. The Intergovernmental Panel on Climate Change (IPCC) has set out a series of Shared Socioeconomic Pathways (SSPs) that vary based on projected GHG emissions over the next century. With increasing projected GHG emissions, there is the potential for a change in the climatic conditions at any given area, e.g., temperature and/or precipitation changes. This can vary depending on the concentration of projected emissions associated with each SSP and chosen timeframe. SSPs are used in this assessment to indicate the impact of varying degrees of warming on the risk associated with each climate hazard. As is standard practice when undertaking climate risk assessments, scenarios are selected based on their appropriateness for any given assessment being undertaken. The SSPs selected for this assessment are:

- **SSP1-2.6**: lower emissions outcome most closely aligned with the Paris Agreement.
- **SSP5-8.5:** which describes a 'business-as-usual' scenario, where global emissions continue to rise unabated. Implied warming may increase by 4.4°C by end of 21st century, with many physical climate risks (e.g., cyclones) increasing in frequency and severity.

Where such uncertainties are material to the ESIA findings, they are clearly stated and are approached conservatively (the precautionary approach), to identify the broadest range of likely residual impacts.

5.1.5.4 Time Horizons

The time horizons used within this assessment have been selected to best align with the expected schedule of the construction and operation phases (Table 5-10). These time horizons reflect the technical view of the assessment team in terms of identifying periods that provide best insight to climate-related trends. Climate data is available for specific future time horizons – typically in 5- or 10-year intervals. For physical climate risk, it is recommended to review trends over generally longer timeframes as it provides a clearer indication of possible emerging issues. The 2030-time horizon is therefore provided as an insight to the possible climate trends for the construction stage and beginnings of the operation stage, whereas 2050 are used to provide insight to the climate trends towards the later stages of the operational phase.

Table 5-10: Time Horizons Included Within the CCRA.

Future Time Horizons Included within this Assessment	Justification
2030	Provides insight to the possible climate trends for the construction period and start of operation phase.
2050	Provides insight as to the climate trends for the operation phase

5.1.5.5 Data and Sources

The projections data collated by ERM for use within this assessment originates from a range of providers, determined to be the best available for demonstrating the change in the hazards included within the assessment.

The main data source is the IPCC, the United Nations's (UN) leading body for assessing the science related to climate change. IPCC releases Assessment Reports (AR), which provide information about the state of scientific, technical, and socio-economic knowledge on climate change, its impacts and future risks, and options for trying to reduce the rate at which climate change is taking place. With each new AR comes a new round of climate models and data developed by the IPCC and Coupled Model Intercomparison Project (CMIP). The last AR (AR6) was published in 2021, marking the latest round of finalized, fully reviewed, and fully published climate data (CMIP6) by the IPCC and CMIP.

5.1.5.6 Approach

The CCRA is conducted through two key steps, namely:

- High-level Physical Screening; and
- High-Level Assessing of the Climate Risks of the Projects.

5.1.5.6.1 High-Level Physical Screening

Step 1 involves a high-level screening assessment to review and document the anticipated climate change impacts within the Project region, including:

- Existing and projected climate, weather extremes and any resultant climate-related risks.
- How climate change is likely to amplify or diminish these climate-related risks.

There are a wide range of climate hazards that have the potential to impact any given Project. ERM has undertaken a high-level scenario-based screening exercise, which involves reviewing the exposure of assets included as a part of the Projects against a range of climate hazards. ERM primarily relied on data provided by its proprietary Climate Impact Platform by ERM and supplemented that data with its propriety Climate Data Tool (CDT) data where necessary and appropriate to produce baseline (aka. Current) and future climate data associated with the Project. The predominant source of data has been global, reputable sources such as NASA, WBG and the IPCC.

5.1.5.6.2 High-Level Risk Review

Based on the results of the high-level physical screening, this step involves conducting a review of the climate data, which has been collected for each hazard included within this assessment. This includes the analysis of baseline and future projected trends for each climate hazard included a review of the potential materiality of any risk present under baseline conditions, and how this risk could potentially change in the future according to any key trends identified within the climate data. Each climate hazard will be assessed in relation to the Project using a mixture of climate data and some qualitative research, which is sourced from industry-leading academic and governmental sources.

ERM collects a series of data variables for each climate hazard included within this assessment. This climate data is collected primarily using Climate Impact Platform by ERM and Global Climate Database (GCD) and is supplemented by any climate data provided by the client as well as the best available online sources of data.

Once the climate data is collected, the trends associated with each variable are assessed for each climate hazard. Following this, ERM undertakes a high-level review of the potential risks posed to the

Project in relation to each climate hazard. This section provides an overview of any impacts (associated with specific hazards), which are identified as being potentially material to specific risk areas associated with the Project (called Site Receptors).

Climate data is collected and discussed in relation to two time periods (2030 and 2050) - 'Risk Materiality Categories' (see Table 5-11) are assigned to all of these two time-periods, representing the start (baseline & construction) and its operations and possible end of operations (till 2050). These two time periods have been selected with an aim to identify the potential change in the level risk posed to the Project by the end of operations, in comparison to the baseline level of risk.

Table 5-11: Risk Materiality Categories and Associated Definitions.

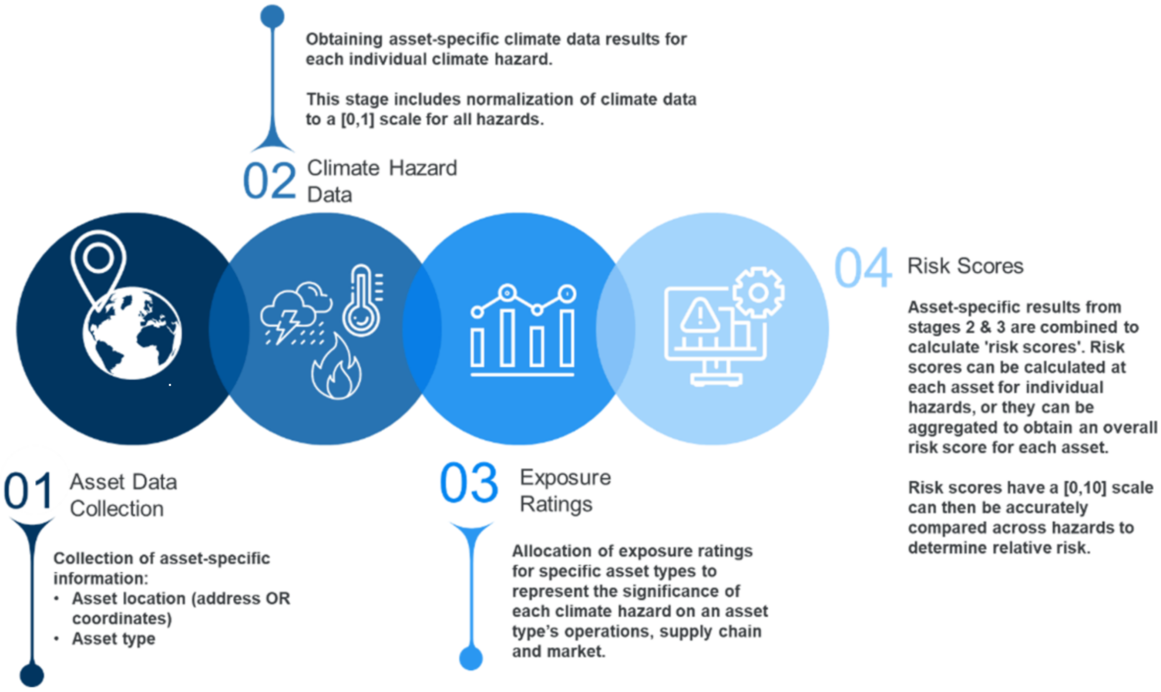
Risk Materiality Category		Definition
Unlikely material		Impacts with this category (such as those related to operational, financial, or other types of impacts) are unlikely to be material. This means that, for example, (a) operational impacts could be expected to be short term, impacting a limited proportion of the overall asset and its operations, or (b) financial impacts would be expected to be minimal relative to the Project's overall revenue and/or costs.
Likely material	Low to moderate	Impacts with this category (such as those related to operational, financial, or other types of impacts) are likely to be of low-moderate materiality. This means that, for example, (a) operational impacts could be expected to be short to medium term, impacting a low to moderate proportion of the overall asset and its operations, or (b) financial impacts would be expected to be small to moderate relative to the Project's overall revenue and/or costs.
	High	Impacts associated with this category (such as those related to operational, financial, or other types of impacts) are likely to be of high materiality. This means that, for example, (a) operational impacts could be expected to be medium to long term, impacting a low to moderate proportion of the overall asset and its operations, or (b) financial impacts would be expected to be moderate to high relative to the Project's overall revenue and/or costs.

5.1.5.7 Climate Impact Platform by ERM

ERM's proprietary Climate Impact Platform by ERM provides an indication of climate trends at site locations. It provides data for key climate physical hazards, such as extreme temperatures, flooding, storms, precipitation-induced landslides, wildfires, and water stress and drought. The platform uses the best available global data sources to provide baseline and future projected results for each climate hazard. The climate data includes the latest round of IPCC and CMIP climate data (CMIP6), amongst other industry-leading sources of data.

Figure 5-2 below outlines the methodology followed by the Platform to complete a screening of physical risks relevant to a single asset or a scope of assets. The goal of a risk screening is to identify assets that have exposure to one or more climate Hazards, and to gain insight on the scale of the magnitude of that exposure.

Figure 5-2: Climate Impact Platform.



5.1.5.8 Assumptions and Limitations

This CCRA provides a high-level review of the possible risks posed to the Project. As a result, this CCRA aims to identify risks and aspects of the Project's design that ERM believes should be assessed further as the Project and its operations progress. There are limitations and assumptions that accompany this type of approach, which should be recognised when interpreting the results of this assessment:

- This is a fully desk-based assessment, meaning that ERM's team has not conducted any on-site visits associated with this CCRA, and thus assessments of the exposure of each asset are based upon information provided by the Client and ERM's research.
- ERM has not sought to verify the accuracy of any information provided by the Client (for example design specifications, observational data provided etc.).
- This assessment uses projected outputs from Global Climate Models (GCMs). This means that GCM data has not been regionally downscaled and validated for the region where the Project is located (no downscaling specific to Nigeria has been undertaken).
- According to MM FZE, the Project site can be considered as UCB Zone 0, which means that there is no Seismic activity in the Project Area. As such, this ESIA does not include an assessment of the potential impact of seismic activity (e.g., earthquakes) on the Project and its operations as these events are associated with, and induced by, seismic activity and therefore not considered a physical climate change event/hazard.
- The Project team has mainly used existing reports and existing Project design reports to gather baseline and future climate data of the Project area. For future climate data, the team uses global data sources from Climate Impact Platform and other sources.

- ERM has made assumptions and limitations where there may be data gaps, e.g., related to the site itself.
- ERM has updated the CCRA undertaken for the Train 3 Project ESIA with any new and port relevant data. No new platform output has been done for MM FZE Port CCRA.

5.1.6 Greenhouse Gas (GHG) Assessment

5.1.6.1 Introduction

As GHG have accumulated in the atmosphere, scientists have recorded a gradual warming of the Earth's average surface temperatures. According to leading scientific organizations, "observations throughout the world make it clear that climate change is occurring, and rigorous scientific research demonstrates that the greenhouse gases emitted by human activities are the primary driver."[4] These heat-trapping gases (or GHGs) include carbon dioxide, methane, nitrous oxide (N_2O), and others.

The GHG assessment presented in Section 5.2.2 estimates the GHG emissions resulting from the Project and compares the magnitude of those emissions with the thresholds developed by IFC. The study does not attempt to quantify the physical impacts of the Project on the global climate, as climate change is a global phenomenon. Scientists predict that further global temperature increases will result in further loss of sea ice, melting glaciers and ice sheets, sea level rise, and more intense heat waves. Severe weather damage will also increase and intensify.

5.1.6.2 Scope

The global standard for GHG reporting—known as the WRI/WBCSD GHG Protocol methodology—divides GHG emissions into three 'Scopes' defined as follows:

- **Scope 1** – direct emissions from sources owned or under the operational control of the company.
- **Scope 2** – indirect emissions from the consumption of purchased electricity (and other energy).
- **Scope 3** – indirect or supply chain emissions, both upstream and downstream, from the reporting entity (e.g., indirect emissions from purchased goods).

For the purposes of this ESIA, emission estimates for the future activities of the Project cover those activities that are under the direct operational control of the project developer. The IFC PS3 (Resource Efficiency and Pollution Prevention) states that '*the client will quantify direct emissions from the facilities owned or controlled within the physical project boundary, as well as indirect emissions associated with the off-site production of energy used by the project'* and therefore this study will focus upon Scope 1 and Scope 2 emissions only, during the operational phase of the Project.

This study does not include an assessment of GHG emissions arising from the construction phase, or an assessment of Scope 3 GHG emissions associated with the manufacture and transport of materials to/from the facility, and other indirect source categories. Scope 3 GHG emissions can be significant but represent a source of indirect emissions that are not under the Project's direct operational control.

[4] Letter to Members of the U.S. Senate by AAAS and 17 Other U.S. Scientific Organizations. October 2009.

5.1.6.3 Methodology

A carbon footprint is a measure of the calculated or estimated GHG emissions produced directly and indirectly by an individual organisation, facility, or product. The calculation of a carbon footprint generally involves the following equation:

$$\textit{Carbon footprint emissions} = \textit{Activity data x Emissions factor x Global warming potential}$$

Where:

- Activity data relates to the emission-causing activity, e.g., the consumption of electricity or the on-site combustion of fossil fuels (in this case, the project consumes natural gas for on-site electricity production);
- Emission factors (EFs) convert the activity data into estimates of GHG emissions (e.g., CO_2 per thousand of cubic feet of natural gas consumption); and
- Global warming potentials (GWPs)[5] are applied to convert the different types of greenhouse gases to a common metric: carbon dioxide equivalent (CO_2e).

Good practice for calculating a carbon footprint dictates that actual monitored data are used in estimating emissions (e.g., kWh electricity consumed, or liters diesel used). Given that this Project involves an estimation of a future carbon footprint for activities yet to begin, assumptions have been made to forecast the activity data required to undertake this calculation. The key assumption (electricity consumption) is based on a comparable port facility owned by the developer in Nigeria: OIS Indorama Port Limited, Onne Port Complex, Onne.

Scope 1 emissions for the Project have been estimated for a single year of operation (365 days). The proposed Project entails the construction and operation of a new Port terminal with all associated utilities to export Urea and Ammonia. The terminal shall have one berth with a capacity to handle and export 1.4 MMTPA of granulated urea and about 150 KTA of Ammonia. Moreover, the terminal will include separate Urea and Ammonia storage and handling systems and associated facilities including – a quay designed for mooring and loading of vessels; a BOG unit for ammonia vapours; an ammonia pumping station from the storage tank to ship; a jetty loading system for Urea; and a jetty loading arm for ammonia. The Project will be powered by four gas engine generators. Direct Scope 1 emissions result from the combustion of natural gas for power generation and use in the ammonia flare stack. Indirect Scope 2 emissions from the consumption of purchased electricity are not applicable as power for the Project would be generated onsite.

[5] A number of different gases contribute to the greenhouse effect. The effect that they have varies according to their relative ability to trap and retain radiant energy arriving at the Earth. These differences are reflected in the gases' global warming potentials (GWP), which are a measure of their greenhouse effect 'strength' relative to CO_2. The GWP of CO2 is 1, methane (CH4) is 25, and nitrous oxide (N2O) is 298 for a 100-year time horizon. Figures are taken from the IPCC's Fourth Assessment Report, in line with the GHG Protocol.

5.2 Impacts to the Physical Environment from Planned Activities

The predicted impacts on the physical environment are presented as follows:

- Risk of Climate Change on the Project (refer to Section 5.2.1)
- GHG Assessment (refer to Section 5.2.2)
- Air Quality Impacts (refer to Section 5.2.3)
- Noise Impacts (refer to Section 0)
- Geology Impacts (refer to Section 5.2.5)
- Soil and Land-use Impacts (refer to Section 5.2.6)
- Groundwater Impacts (refer to Section 5.2.7)
- Surface Water Impacts (refer to Section 5.2.8)

5.2.1 Risk of Climate Change on the Project

5.2.1.1 Identified Climatic Hazards

As part of the CCRA, relevant hazards deemed relevant to the Project Area were identified. Various data sources were consulted for use within this assessment (refer to Chapter 4), including baseline information and projections data. Existing baseline data has been used to provide an indication of the presence and potential severity of climate hazards under present day conditions.

The climate hazards / types deemed applicable and reviewed in this assessment include:

- Extreme Heat;
- Extreme Cold;
- Extreme Rainfall and Flooding;
- Water Stress & Drought, and
- Wildfires.

Tropical storms, cyclones, coastal flooding and extreme storms and winds were not included in this assessment, as no relevant data for the Project Area's location were found.

Data results were obtained for several climate hazards to understand the present-day conditions and projected changes of each hazard at the Project Area location (as presented in *Chapter 4*). The rationale for the inclusion of each event / hazard is included in Table 5-12.

Overall, Extreme Heat is the most predominant and most significant hazard for the Project Area. There is a direct link between Extreme Heat and Water Stress & Drought and Wildfires, which were also identified as being significant. Moreover, precipitation is also projected to increase in intensity, quantity, and severity, which in turn increases the risk of flooding.

5.2.1.2 Sensitive Receptors

Table 5-13 and Table 5-14 provide an overview of the Project elements (site receptors) during the construction and operational phases that can be deemed as being susceptible to climate change risks.

5.2.1.3 Potential Impacts to Sensitive Receptors

Table 5-15 and Table 5-16 provide an analysis of those Project elements (otherwise known as sensitive receptors) that are potentially exposed to climate risks during the construction and operational phases respectively for each of the identified above hazard types. Those risks included in bold and highlighted are identified as risk items likely to be of greater materiality to the Project and therefore should be considered in future climate change risk assessment studies.

Table 5-12: Rationale for Hazard Inclusion.

Climate Hazard	Will the Hazard be Included?	Rationale for Inclusion
Extreme Heat	Yes	Historical (for construction): Historically the heat index is rated as being a likely material. Projections (for operation): Trends of average monthly temperatures and number of extreme heat days are projected to have significant increases into 2030 and 2050. This hazard has the potential to impact the site during the construction and operation phases and is therefore included in this assessment
Extreme Cold	No	Historical (for construction): Historically the lowest monthly temperature is rated as being likely present and likely material. Projections (for operation): Trends in extreme cold conditions and number of cold days are projected to decrease significantly into 2030 and 2050 and possibly at worst case scenario to have no risk at all. This hazard is unlikely to impact the site during the construction and operation phases and is therefore not included in this assessment.
Extreme Rainfall Flooding *Including hail, lightning & tornadoes*	Yes	Historical (for construction): Historically precipitation and Extreme Rainfall Flooding is rated as being likely present and likely material. Projections (for operation): Trends in extreme precipitation, increases in quantity, intensity and extreme events that may lead to Extreme Rainfall Flooding are projected to increase in 2030 and 2050 with the worst-case scenario in 2050 having Extreme Rainfall Flooding being one of the three main hazards for the site. This hazard has the potential to impact the site during the construction and operation phases and is therefore included in this assessment.
Water Stress & Drought	Yes	Historical (for construction): Historically water risk is rated as being high. Projections (for operation): Water stress and drought events and the duration of heat waves are projected to increase in 2030 and 2050. This hazard has the potential to impact the site during the construction and operation phases and is therefore included in this assessment.
Wildfires	Yes	Historical (for construction): Historically wildfire risk is rated as being likely material. Projections (for operation): Drought and temperature trends suggest a significant projected increase in this hazard for 2030 and 2050. Although wildfires have been flagged as a potentially material hazard for the broader Project Area it must be noted that the risk of wildfires is not material in that the actual Project site is situated in an area where year-round relative humidity is in excess of 70% and in an area that has a high annual rainfall (above 2,300 mm).

Table 5-13: Project Site Receptors: Construction Phase.

Receptor Type	Site Elements	
Machinery	Construction equipment	Construction vehicles / trucks
Storage & Materials	Construction materials (cement, steel, etc.)	Diesel fuel
Structures & Operations	Power supply (Gas engine generators - GEG)	
Infrastructure (On site & off-site surface)	Potable and construction water Waste disposal facilities	Wastewater treatment/disposal
Transport	Site access roads Vehicles	Internal roads, parking areas and walkways
Human (staff and community)	Staff working at port	Surrounding port terminals and its facilities

Table 5-14: Project Site Receptors: Operational Phase.

Receptor Type	Site Elements	
Machinery	Operations equipment	Operations trucks / vehicles
Structures & Operations	Flare stack Cooling tower Firefighting system fire water pumps Ammonia unloading and pumping station. Urea truck unloading station (dedusting unit) BOG reliquefication unit Plant and instrument air units	Sewage treatment unit Power generation systems (generators, natural gas engines) Intake and outtake system (belt conveyors, bucket elevator portal scrapper reclaimer & ship loader, dedusting unit) Weighbridges Oil water separator Quay

Receptor Type	Site Elements	
Infrastructure (On site & off-site surface)	Substation and control room Electrical power distribution network Security building Administration building Amenities building Jetty Maintenance/Workshop building Oil and Chemical storage Urea Storage warehouse Nitrogen storage Ammonia Storage Tank CNG (Compressed Natural Gas) Storage modules	Borewell Fresh water storage tanks Water treatment Urea loading system Ammonia loading arms Ammonia ship loading pumps Fire and gas Detection system Fire water pump network (pump house) Fire foam storage
Transport	Site access roads Vehicles	Internal roads, parking areas and walkways
Human (staff and community)	Staff working at port	Surrounding port terminals and its facilities

Table 5-15: Potential Impacts to Site Receptors during the Construction Phase.

Climate Hazard	Risk Item	Potential Impact to Site Receptor Type					
		Machinery	Storage & Materials	Structures & Operations	Infrastructure (On site & off-site surface)	Transport	Human
Extreme Heat	Could disrupt and / or delay construction.	Reduced efficiency of equipment / engines due to higher ambient temperatures.		Overheating of generators.	Overheating of waste disposal facilities, wastewater treatment/disposal.		
	May disrupt and / or delay debris and other material being removed from site, and vehicles coming on to site.	Days of extreme and prolonged heat periods could cause cracks and potholes in the road surface.				Overheating of vehicles / trucks. Days of extreme and prolonged heat periods could cause cracks and potholes in the road surface.	
	Could result in health issues for workers.	Delays in removing materials from site due to health issues of workers.					Prolonged heat causing fatigue, sunstroke, and other related health issues, which could result in restricted working hours or work delays due to shortages of staff.
Extreme Precipitation & Extreme Rainfall Flooding	Heavy precipitation with extreme flooding can restrict site access.	Heavy precipitation may result in surface runoff on access and internal roads.	Potential delays in raw material delivery due to wet and flooded roads.			Flooding of roads during heavy precipitation causing road closure and delays of vehicles / trucks onto site.	
	Heavy precipitation with extreme floods can delay construction operations.	Disable construction equipment resulting in delays due to flooding. Damage to equipment and possible washing away of equipment during flooding.		Building interruptions and complications due to flooding.		Flooding of roads causing road closure and delays of vehicles onto site.	
	Heavy precipitation with extreme floods can damage site infrastructure and material.		Loss of construction materials which are washed away due to flooding.	Damage to generators by flood waters.	Extreme flooding could damage infrastructure.		Inaccessible or unsafe working conditions for staff.
	Heavy precipitation with extreme flooding can lead to reducing surface water quality.						Severe precipitation events reducing surface water quality, affecting clean water availability for workers.
	Heavy precipitation with extreme flooding, has the potential to result in injuries / illness to workers or delay in work.						Risk of injuries due to both surface and flowing water. Potential spread of waterborne disease as a result of standing water (e.g.: cholera etc.).
Water Stress & Drought	Prolonged and more frequent dry periods result in higher water consumption for construction.		Decrease in water used for construction, and if dry spells are longer leading to water shortages.	Decrease in water used for construction and if dry spells are longer leading to water shortages.			

Climate Hazard	Risk Item	Potential Impact to Site Receptor Type					
		Machinery	Storage & Materials	Structures & Operations	Infrastructure (Onsite & off-site surface)	Transport	Human
	Prolonged and more frequent dry periods result in higher evaporation.		Higher evaporation can lead to less water being available for construction.	Higher evaporation and water shortages in water can lead to an increase in the withdrawal of more water for construction.			
	Prolonged and more frequent dry periods result in dust generation (dust storms) for the project.	Impacts on visibility along transportation corridors.				Impacts on visibility along transportation corridors.	Impacts on health and safety of site personnel, e.g.: respiratory issues.
Wildfires	Restrict access to roads.	Delays in getting construction equipment & vehicles to site due to access problems.	Delays in getting materials to site due to wildfires causing access problems.			Restricting access to roads, potential delays to construction.	Prevent site staff from accessing their workplace.
	Damage temporary facilities, infrastructure.				Potential damage from wildfires to onsite facilities, infrastructure.		
	Delay or interrupt construction.		Impact of fire damages to construction site.				
	Damage equipment.	Possible damage to equipment from wildfires.					
	Health issues for workers.						Impacts on health and safety e.g.: respiratory issues, burns, air quality for staff.

Note: Those in ***bold*** *and highlighted are identified as risk items likely to be of greater materiality and therefore should be considered in detail for future studies.*

Table 5-16: Potential Impacts to Site Receptors during the Operations* Phase.

Climate Hazard	Risk Item	Potential Impact to Site Receptor Type				
		Machinery	Structures & Operations	Infrastructure (On site & off-site surface)	Transport	Human
Extreme Heat	Could disrupt and / or delay operations.	Reduced efficiency of equipment / engines due to higher ambient temperatures.	Heat stress to various steel structures by thermal expansion. Extreme heat may cause overheating to power generation systems. Additionally, temperature control mechanisms may need to work harder to maintain optimal operating conditions, resulting in increased energy consumption.	Increased use of air conditioning at staff sites over an increased period.	Extreme heat causing overheating of operation vehicles / trucks.	
	May disrupt and / or delay transport vehicles onto and off site.	Days of extreme and prolonged heat periods could cause cracks and potholes in the road surface.			Days of extreme and prolonged heat periods cause cracks and potholes in the road surface.	
	May result in damage to operation infrastructure.			Extreme heat could damage infrastructure and hence delay operations. Extreme heat may cause overheating to electrical power disruption network, substations. Extreme heat may cause pressure valve to open and therefore lead to Natural gas leakage.		
	Could result in health issues for workers.					Heat impacting workers, resulting in health issues and restricted working hours and work delays due to shortages of staff.
Extreme Precipitation & Extreme Rainfall Flooding	Heavy precipitation with extreme flooding can restrict site access.	Heavy precipitation with flooding may result in surface runoff on access and internal roads.			Waterlogging of road surface during flooding, creating surface cracking.	
	Heavy precipitation with extreme floods can delay operations.	Disable operation equipment resulting in delays due to flooding. Damage to equipment and possible washing away of equipment during flooding.		Extreme flooding could damage infrastructure. Maintenance of port site difficulties. Flooding causes damage to structures (including offices, warehouses, workshops, storages). Damage to buildings by floodwaters.	Flooding of roads during heavy precipitation causing road closure. Flooding of roads during heavy precipitation causing road closure and delays of vehicles / trucks onto site.	
	Heavy precipitation with extreme flooding can lead to reducing surface water quality.					Severe precipitation events reducing surface water quality, affecting clean water availability for workers.
	Heavy precipitation with extreme flooding has the potential to result in injuries / illness to workers or delay in work.					Risk of injuries due to both surface and flowing water. Potential spread of waterborne disease because of standing water (e.g.: cholera etc.).

Climate Hazard	Risk Item	Potential Impact to Site Receptor Type				
		Machinery	Structures & Operations	Infrastructure (Onsite & off-site surface)	Transport	Human
Water Stress & Drought	Prolonged and more frequent dry periods' result in higher water consumption for operation.		Decrease in water available for operation and if dry spells are longer leading to water shortages.	Decrease in water available for operation and if dry spells are longer leading to water shortages.		
	Prolonged and more frequent dry periods result in higher evaporation.		Higher evaporation and water shortages can lead to an increase in the withdrawal of more water for operation.	Higher evaporation and water shortages can lead to an increase in the withdrawal of more water for operation.		Higher evaporation and water shortages due to extreme heat can lead water pipelines decreasing in depth and area if dry spells are longer leading to water shortages.
Wildfires	Wildfires damage operations.			Potential damage to structures (including offices, warehouses, workshops, storages) from wildfires.		
	Wildfires restrict access to roads.	Delays in getting operation vehicles / trucks to site due to access problems.			Restricting access to roads, potential delays to operation.	
	Wildfires damage infrastructure.	Possible damage to equipment from wildfires.		Possible fire damage to water supply infrastructure.		
				Possible damage as a result of wildfires to urea, ammonia, nitrogen storage and may result in explosions.		
				Potential damage from wildfires to pipeline system, electrical power distribution network and associated infrastructure, substation.		
				Damage to building's due to fires.		
	Wildfires have the potential for health issues for staff.					Impacts on health and safety, e.g.: respiratory issues, burns, air quality for staff.

*Note: Those in **bold** and highlighted are identified as risk items likely to be of greater materiality and therefore should be considered in detail for future studies.*

**Operations - It is to be noted that for operations we have taken the worst-case scenario.*

5.2.2 GHG Assessment

5.2.2.1 Description of the Baseline Environment

The Project includes a compressed natural gas (CNG) storage module to be used for power generation. Power generation will be by means of three gas engine generators with a capacity of 1500kVA and one generator with a capacity of 800kVA. In order to estimate the GHG emissions from the Project, ERM relied on estimates of the electricity use by the different components, as detailed in Table 5-17. These estimates are based on an identical port facility owned by Indorama: OIS Indorama Port Limited, Onne Port Complex, Onne.

Table 5-17: Estimated Electricity Use (Port Operations).

Power Requirements	Power consumption	Hours/day	kWh/day	Ships per year	Annual Consumption
Day utility power consumption	150 kw	12	1,800	n/a	657,000 kWh
Night utility power consumption	250 kw	12	3,000	n/a	1,095,000 kWh
Unloading/storage system power consumption	220 kw	16	3,520	n/a	1,284,800 kWh
Vessel loading system	500 kw			30 (48 hrs/load)	720,000 kWh
TOTAL					3,756,800 kWh

The Project will also include an ammonia storage facility. This will add additional electric load and emissions. Again, Indorama was able to provide ERM with estimates of the electrical load for the various components of the facility, as detailed in Table 5-18.

Table 5-18: Estimated Electricity Use (Ammonia Storage).

Power Requirements	Power consumption	Hours/day	Kwh/day	Annual Consumption
Loading arm and motors	69 kw	0.03	2.3	840 kWh
Pumping power requirement	105.61 kw	0.03	3.52	1,285 kWh
BOG power	168 kw	24	4,032	1,471,680 kWh
Utility power (e.g., CNG heater)	40 kw	24	960	350,400 kWh
Miscellaneous power requirements (e.g., CCTV)	30 kw	24	720	262,800 kWh
TOTAL				2,087,004 kWh

ERM then calculated the annual CO2 emissions associated with the estimated electrical load of the Project operations and ammonia storage facility based on the following conversion factors and efficiency assumptions. The power factor (3,300) is a worst-case assumption, annual CO2 emissions based on the actual power consumption can be obtained as follows:

$$Annual\ CO_2\ emissions\ (Kg)$$
$$= annual\ MWhX1000\ (\frac{KWh}{MWh}) \times \frac{3{,}300\ [Kcal]}{KWh} \times\div 8650(\frac{Kcal}{Nm3}) \times \frac{44\ Kilo\ grams\ CO_2}{22.414\ Nm3}$$

Annual Co2 emissions (MT) = Annual CO2 emissions (kg) / 1000

Table 5-19: Estimated CO2 Emissions (Electricity Use)

Operations	Annual Electricity Consumption	CO_2 Emissions
Port Operations	3,756,800 kWh	2,814 metric tons
Ammonia Storage	2,087,004 kWh	1,563 metric tons
TOTAL	5,843,804 kWh	4,376 metric tons

Additional CO_2 emissions will be generated from the flaring of methane gas (CNG storage). MM FZE estimated six normal cubic meters of gas flaring per hour. Using the same natural gas conversion factors, above this translates to an additional 99 metric tons of CO_2 emissions per year from flaring operations.

The IFC PS 3 suggests that projects quantify their GHG emissions if they are expected to produce more than 25,000 metric tons of CO_2-equivalent per year. The Project is well below this recommended threshold at 4,475 metric tons per year.

5.2.2.2 Summary of GHG Assessment Findings

The Project's annual GHG emissions are estimated at 4,475 metric tons, including both the port operations and ammonia storage facility. Emissions are primarily attributable to the combustion of natural gas for on-site electric power generation. The Project will not rely on imported grid electricity (i.e., no Scope 2 emissions). The estimated emissions are well below the reporting threshold recommended by the IFC (i.e., 25,000 metric tons per year).

5.2.3 Air Quality Impact Assessment

5.2.3.1 Description of the Baseline Environment

The pollutants of interest for the Project are:

- Nitrogen dioxide (NO_2)
- Ammonia (NH_3)
- Particulate matter as PM_{10} and $PM_{2.5}$

Monitoring undertaken around the port facility has identified that the baseline environment for all of these pollutants is undegraded in both the dry and wet seasons.

5.2.3.2 Proposed Project Activities

5.2.3.2.1 Construction Dust

The construction of the Project has the potential to result in emissions of dust and PM_{10} to air. The impacts are assessed as per Infographic 1 below (Figure 5-3). Depending on whether the impact magnitude is Small, Medium or Large, the relevant mitigation is identified to control impacts to be, at worst, Minor impact. This approach works on the basis that construction dust impacts are readily mitigated with suitable control, particularly at a location like that of the Project, which is relatively small, contained and with ready access to water for abating dust.

5.2.3.2.2 Construction Traffic

The construction of the facility will also generate road traffic. The levels of road traffic are anticipated to be below the thresholds that could potentially adversely impact on air quality, based on the screening thresholds as per Figure 5-4.

5.2.3.2.3 Operational Traffic

The operation of the facility will also generate road traffic. The levels of road traffic are anticipated to be below the thresholds that could potentially adversely impact on air quality, based on the screening thresholds as per Figure 5-4 previously presented.

Figure 5-3: Infographic for Air Quality Assessment of Dust.

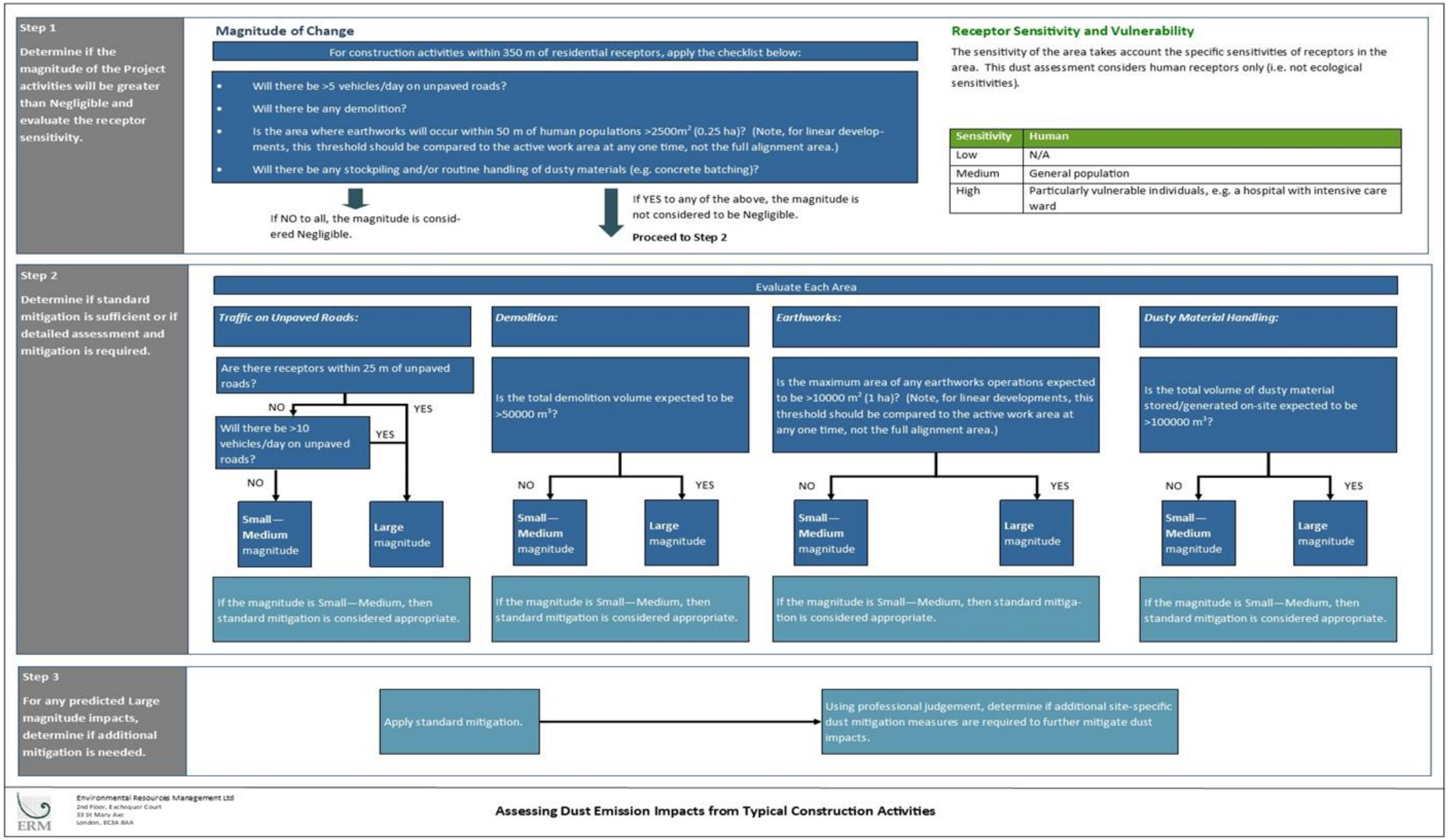
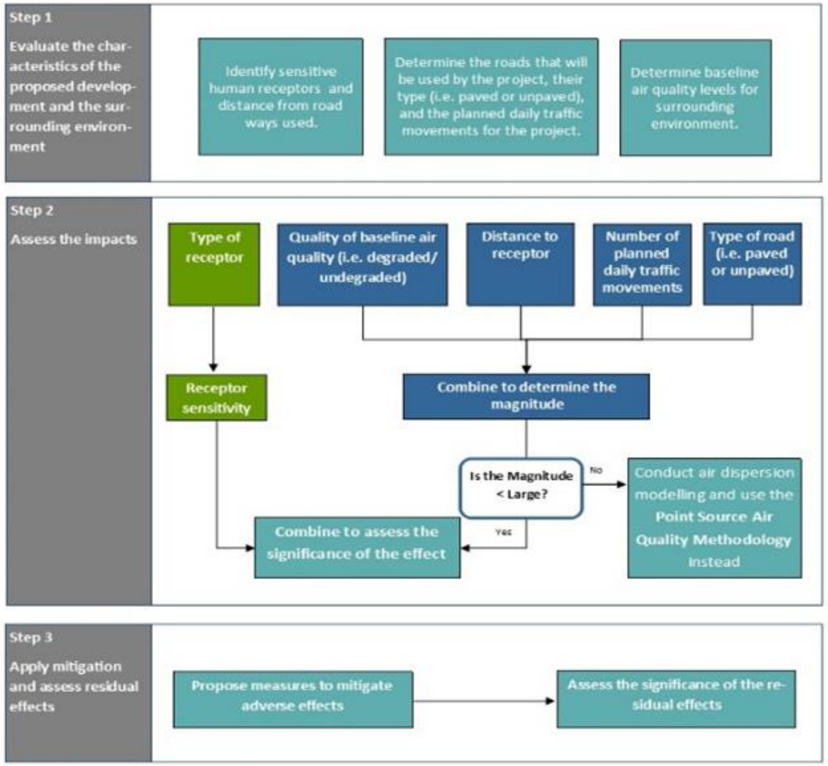


Figure 5-4: Traffic infographic for Air Quality Assessment.

Overview

The IFC are not prescriptive in determining the threshold of road traffic which may result in significant impacts. The only guidance provided is that operators of fleets with greater than 120 Heavy Goods Vehicles should consider using lower emission vehicles. This methodology is therefore based upon the UK Highways Agency Design Manual for Roads and Bridges assuming Euro 3 or equivalent fleet .

The methodology is based upon the calculated increases in vehicles needed to trigger the significance thresholds, based upon the interpretation of the IFCs significance criteria.



Receptor Sensitivity

Note that this methodology applies only to human receptors (i.e. not ecological receptors). The table below provides receptor sensitivity with respects to human health.

Sensitivity	Description
Negligible	N/A
Low	N/A
Medium	General population
High	Particularly vulnerable individuals, e.g. a hospital with intensive care ward

Magnitude of Change

The magnitude of the impacts to air quality from project traffic are determined using the combination of factors illustrated to the left. The first step in this process is identifying the relative level of traffic.

Road Type	Type of Traffic	Annual Average Daily Traffic (AADT), e.g. number of traffic movements	Level of Project Traffic (Relative to the Baseline Air Quality)	
			Undegraded Airshed	Degraded Airshed
Paved Roads	Heavy Duty Vehicles (HDV)	<440	Negligible	Negligible
		<1000	Negligible	Small
		<3200	Small	Medium
		<15000	Medium	Large
		>15000	Large	Large
	Light Duty Vehicles (LDV)	<7600	Negligible	Negligible
		<17000	Negligible	Small
		<55000	Small	Medium
		<250000	Medium	Large
		>250000	Large	Large

This methodology applies to road traffic exhaust emissions. Emissions of dust arising from the use of unpaved roads by vehicles is assessed separately .

The magnitude can then be determined using the matrix below.

Level of Project Traffic	Distance of Receptor to Road				
	>100m	<100m	<50m	<20m	<5m
Large	Negligible	Small	Medium	Large	Large
Medium	Negligible	Small	Small	Medium	Large
Small	Negligible	Negligible	Negligible	Small	Small
Negligible	Negligible	Negligible	Negligible	Negligible	Negligible

ERM

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Assessing Air Quality Impacts from Road Traffic

5.2.3.2.4 Operational Port Facility

The proposed activities during the operational phase of the Project that could potentially impact on air quality are set out below. There are also embedded mitigation measures in place to contain any emissions arising:

- Urea granules storage and loading:
  - Urea storage and handling
  - Solid/granulated product
  - Tipper Trucks 40 tonne unloading and open conveying
  - Urea fertiliser warehouse:
  - Handling 52000 metric tonnes per year
  - Contained and enclosed tipping and handling processes with air extraction
  - Urea loading to ships:
  - Reclaimer
  - Belt conveyor
  - Ship loading

The urea granules are delivered to the port in covered tipper trucks and unloaded. This operation is undertaken using a dedusting system to minimise dust emissions. The tipping activities and loading of the product to the conveyor are undertaken within the enclosed warehouse. The warehouse has active air extraction to maintain the quality of the urea and dust emissions and collected using the dedusting system. The urea transfer from unloading station to warehouse to ship loader will be through an enclosed conveyor belt system.

- The ammonia handling and storage processes consists of:
  - Ammonia tanker unloading
  - Ammonia liquid storage at atmospheric pressure but -33^{0}C
  - Boil off gas reliquification unit
  - Ammonia ship loading
  - Ammonia overpressure emergency flare

Ammonia is gaseous at ambient temperatures are as such the ammonia is cooled to -330C and contained within a sealed system. Boil off ammonia gas is reliquefied and returned to the storage facility, and the entire system is wholly enclosed with no routine emissions to minimise product losses.

- Power generation will consist of:
  - The port facility will utilise ~5$MW_{thermal}$ natural gas fired generators to provide power (3 x 1500KVA + 1 800KVA unit)

The generators will be designed with stacks that are roof height +3m and vertical to optimise dispersion of emissions and mitigate impacts. The engines are of small capacity, and using natural gas have lower emissions than similar engines using diesel.

5.2.3.3 Sensitive Receptors

There are settlements nearby to the Project including Owo Ogono to the southeast, and Onne to the north. There are also commercial and industrial processes adjacent to the facility. Due to the expectation that there will be no significant impacts anywhere offsite, there is no requirement to study receptors in any detail.

5.2.3.4 Significance of Impacts (Pre-mitigation)

5.2.3.4.1 Construction Phase: Dust

Following the methodology set out above, the activities that could potentially result in dust emissions for the Project have been reviewed and are as follows:

- Earthworks: there are earthworks >10,000m^2, therefore the potential impacts are Large.
- Traffic on unpaved roads: there is no traffic on unpaved roads <25m from sensitive receptors, therefore the potential impacts are Small.
- Demolition: there is no demolition, therefore the potential impacts are Small.
- Handling of dusty materials: there is the potential for activity on an area of >100,000m^2, therefore the potential impacts are Large.

The dust assessment identified that there is the potential for significant dust emissions to arise from some construction activities on site. Based on the analysis provided above, the impact from construction dust will be a "**Minor**" pre-mitigation (Table 5-20).

There is the potential for dust and PM_{10} to be emitted from the construction activities. However, these emissions and impacts are readily mitigated with basic mitigation measures.

Table 5-20: Rating of Impacts Related to Construction Dust (Pre-Mitigation)

Type of Impact		
Air Quality: Construction Dust		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Vicinity of the construction activities no more than 350m from sources, receptors principally >350m away (some commercial and industrial facilities are dust sensitive)
Duration	Short term	Construction will be temporary activity
Scale	Small	Impacts will be limited to vicinity of construction site
Frequency	Continuous	Emissions will arise throughout construction
Magnitude		
Small Magnitude		

Sensitivity/Vulnerability/Importance of the Resource/Receptor
Low Sensitivity
The main receptors are commercial and industrial facilities near the port. These are low sensitivity but may have some activities that are vulnerable to dust impacts.
Significant Rating Before Mitigation
Minor Impact

5.2.3.4.2 Construction Phase: Traffic

Based on the analysis provided above, the impact from construction traffic will be a "**Negligible**" pre-mitigation (refer to Table 5-21).

There will be emissions arising from construction traffic accessing the site for the duration of construction activities.

Table 5-21: Rating of Impacts Related to Construction Traffic (Pre-Mitigation).

Type of Impact		
Air Quality Construction Traffic		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Alongside main routes used to access construction site
Duration	Short term	Construction will be temporary activity
Scale	Small	Impacts will be limited to main routes accessing construction site
Frequency	Continuous	Emissions will arise throughout construction
Magnitude		
Negligible Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
There are residential and commercial receptors in the vicinity of the access roads, including settlements.		
Significant Rating Before Mitigation		
Negligible Impact		

5.2.3.4.3 Operational Phase: Traffic

Based on the analysis provided above, the impact from operational traffic will be a "**Negligible**" pre-mitigation (refer to Table 5-22).

There will be emissions arising from operational traffic accessing the site for the duration of operation of the Project. The daily traffic numbers are insufficient to trigger potentially significant impacts at sensitive receptors.

Table 5-22: Rating of Impacts Related to Operational Traffic (Pre-Mitigation).

Type of Impact		
Air Quality Operational Traffic		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Alongside main routes used to access the Project site
Duration	Long term	Operational traffic will be generated throughout the lifetime of the Project
Scale	Small	Impacts will be limited to main routes accessing the Project site
Frequency	Continuous	Emissions will arise throughout operation
Magnitude		
Negligible Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
There are residential and commercial receptors in the vicinity of the access roads, including settlements.		
Significant Rating Before Mitigation		
Negligible Impact		

5.2.3.4.4 Operational Phase Facility

MM FZE informed ERM that all that the design of the material handling facilities are inherently designed to control dust emissions. Measures include: enclosure of the tipping area; enclosure of the urea warehouse; cover of the conveyor; use of active air extraction and dedusting. As such, the impacts from material handling will be Negligible.

As noted, there is a small amount of power generation at the site. Given that this is gas fired and <3MW, it is considered sufficiently small to not result in significant impacts to air quality and therefore impacts are negligible.

Ammonia handling is a closed circuit with boil off gas recovery to recapture product resulting in no routine emissions.

Based on the analysis provided above, the impact from the operation of the Project will be a "**Negligible**" pre-mitigation (refer to Table 5-23).

Table 5-23: Rating of Impacts Related to Operation of the Port (Pre-Mitigation).

Type of Impact		
Air quality – operations		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Impacts will be limited to the area immediately around the Project site
Duration	Long-term	Impacts will arise throughout the duration of Project operations
Scale	Small	Impacts are limited to adjacent to the Project site
Frequency	Continuous	Impacts will arise throughout operation
Magnitude		
Negligible Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		
The primary receptors are adjacent commercial and industrial facilities		
Significant Rating Before Mitigation		
Negligible Impact		

5.2.3.5 Residual Impact (Post-mitigation)

5.2.3.5.1 Construction Phase Dust

Based on the implementation of the proposed mitigation measures, the significance of the impact to air quality from construction dust will be "**Negligible**" post mitigation (refer Table 5-24).

Table 5-24: Rating of Residual Impacts Related to Construction Dust (Post-Mitigation).

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Vicinity of the construction activities no more than 350m from sources, receptors principally >350m away (some commercial and industrial facilities are dust sensitive)
Duration	Short term	Construction will be temporary activity
Scale	Small	Impacts will be limited to vicinity of construction site
Frequency	Continuous	Emissions will arise throughout construction
Magnitude		
Negligible Magnitude		
Significant Rating After Mitigation		
Negligible Impact		

5.2.3.5.2 Construction Phase Traffic

Based on the implementation of the proposed mitigation measures, the significance of the impact to air quality from traffic dust during construction will be "**Negligible**" post mitigation (refer to Table 5-25).

Table 5-25: Rating of Residual Impacts Related to Construction Traffic (Post-Mitigation).

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Alongside main routes used to access construction site
Duration	Short term	Construction will be temporary activity
Scale	Small	Impacts will be limited to main routes accessing construction site
Frequency	Continuous	Emissions will arise throughout construction
Magnitude		
Negligible Magnitude		
Significant Rating After Mitigation		
Negligible Impact		

5.2.3.5.3 Operational Phase Traffic

Based on the implementation of the proposed mitigation measures, the significance of the impact to air quality from traffic during the operational phase will be "**Negligible**" post mitigation (refer to Table 5-26).

Table 5-26: Rating of Residual Impacts Related to Operational Traffic (Post-Mitigation).

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Alongside main routes used to access the Project site
Duration	Long term	Operational traffic will be generated throughout the lifetime of the Project
Scale	Small	Impacts will be limited to main routes accessing the Project site
Frequency	Continuous	Emissions will arise throughout operation
Magnitude		
Negligible Magnitude		
Significant Rating After Mitigation		
Negligible Impact		

5.2.3.5.4 Operational Phase Port

Based on the implementation of the proposed mitigation measures, the significance of the impact to air quality as a result of port operations will be a "**Negligible**" post mitigation (refer to Table 5-27).

Table 5-27: Rating of Residual Impacts Related to Operational Phase (Post-Mitigation).

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Impacts will be limited to the area immediately around the Project site
Duration	Long-term	Impacts will arise throughout the duration of the Project operations
Scale	Small	Impacts are limited to adjacent to the Project site
Frequency	Continuous	Impacts will arise throughout the operational phase
Magnitude		
Negligible Magnitude		
Significant Rating After Mitigation		
Negligible Impact		

5.2.3.6 Impacts from Unplanned Events

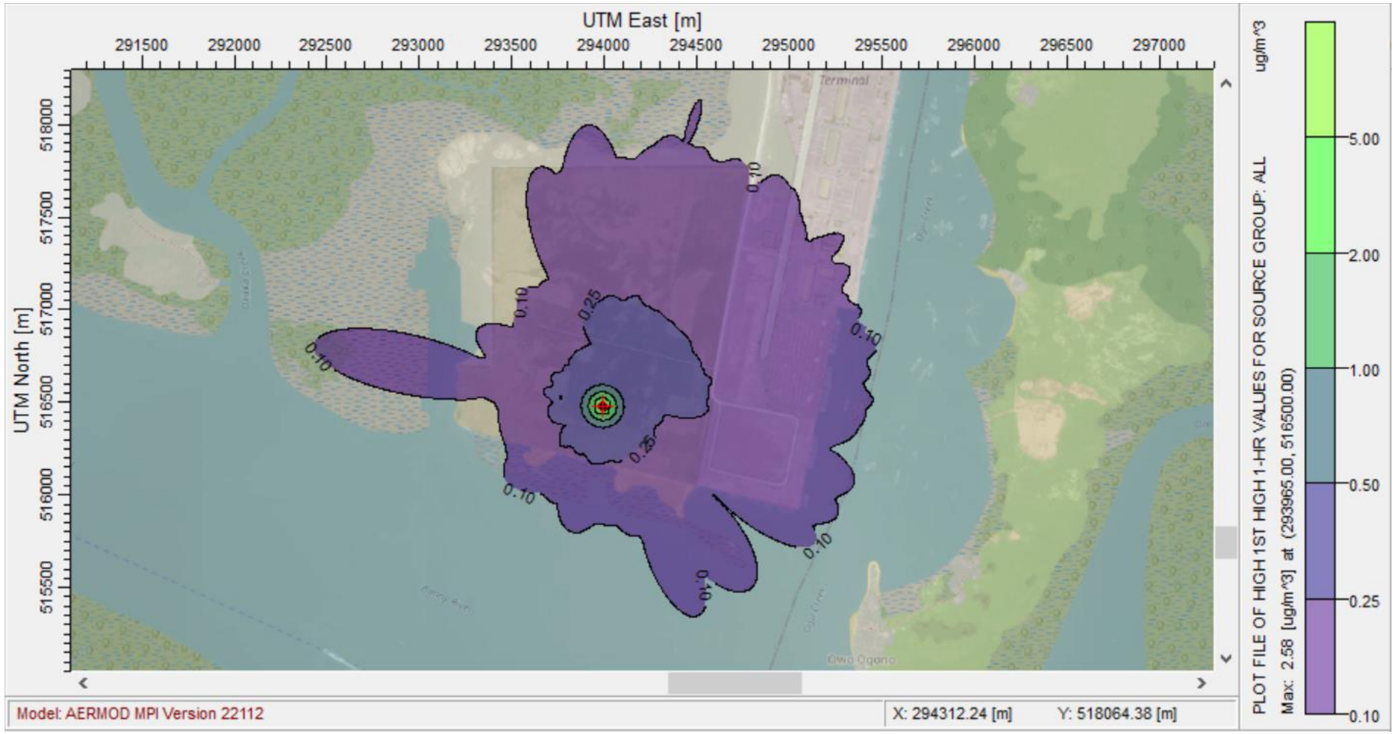
The port will be equipped with a flare to dispose of excess ammonia in the event of an overpressure event. As noted, the impacts of the flaring have been modelled. As events are short term, only the 1-hour NO_2 standard is of interest. The modelling indicated that the impacts of a flaring event are shown in Table 5-28 and Figure 5-5.

The PC is less than 25% of the AQS, and therefore considering that the baseline NO_2 is undegraded impacts of the flaring event are of negligible significance. Furthermore, the likelihood of an unplanned event is very low, and not anticipated to arise during the operation of the facility.

Table 5-28 : AIR Quality Impacts: Emergency Flaring

Pollutant	Averaging Time	Origin of Standards	Environmental Assessment Levels (EALs) µg/m³	Baseline µg/m³	PC (max)		PEC (max)		Magnitude	Significance
					µg/m³	% AQS	µg/m³	% AQS		
NO_2	1h, max	Nigeria/IFC	200	28.8	2.58	1.3%	31.4	15.7	Negligible	Negligible

Figure 5-5: Air Quality Impacts: Emergency Flaring



5.2.4 Noise Impact Assessment

Note – the impacts associated with underwater noise from Construction on estuarine biota is discussed in detail in Section 5.3.2 and are not repeated here.

5.2.4.1 Description of the Environment

Noise baseline measurements were undertaken at 14 locations – 12 locations within the Project Area and two locations that were representative of the acoustic environment at NSRs around the vicinity of the Project. Measured noise levels are generally low, and below the day and nighttime IFC criteria and the Nigerian standards for Mixed residential receptors at all measurement locations.

5.2.4.2 Sensitive Receptors

The Project Area is located next to an existing industrial area and operating port. The nearest NSRs are the Owo Ogono community, approximately 1.4 km southeast of the Project Area and the Ele community, approximately 2.5 km northeast from the Project Area.

5.2.4.3 Significance of Impacts

Noise emissions during construction and operation have the potential to significantly increase the noise levels within the Project boundaries and at areas near the boundaries. As mentioned previously, the nearest receptor (Owo Ogono community) is located 1.4 km away from the Project's boundaries, and therefore to exceed the noise criteria, as defined by the WBG EHS Guidelines, the overall sound power level should not exceed 120 dB during nighttime and 130 dB during day time.

Typical overall sound power levels of construction activities such as site clearance and structures construction, are within 115 to 120 dB. Construction activities will take place only during daytime hours, and therefore noise impacts during construction are anticipated to have negligible impact on NSRs in the proximity of the Project.

Most of the operation equipment will be enclosed within structures and spread within a greater area. Noise emissions during typical operation are anticipated mostly from jetty operation, power generator plant, ammonia pump station, BOG, operation traffic, CNG, etc. Operational noise levels are likely to exceed the relevant noise criteria during night time. In addition, during emergency, flare will also operate. Noise levels during flaring can increase significantly, and therefore noise levels at NSRs might exceed the criteria. However, flare events will be irregular and of short duration.

If construction and operation activities exceed the sound power levels mentioned above, then mitigation measures should be considered. With the implementation of the right mitigation measures during construction and operation, overall sound power levels can decrease to levels lower than 120dB resulting a negligible impact.

To ensure that noise limits will not be exceeded during construction and operation, it is recommended that compliance monitoring be undertaken on a regular basis (monthly) via direct measurement at Owo

Ogono community. In the event of an exceedance of the criteria are identified, a Noise Management Plan (NMP) needs to be implemented to investigate the cause of the noise source and implement corrective actions to minimise the impact.

5.2.5 Geology Impact Assessment

5.2.5.1 Description of the Baseline Environment

The formation of the present-day Niger Delta started in the early Paleocene era and resulted in the build-up of fine-grained sediments eroded and transported by River Niger and its tributaries. The subsurface geology of the Niger Delta consists of three lithostratigraphic units (Akata, Agbada and Benin Formations), which are overlain by various types of quaternary deposits.

The geology of the Project site is composed of coarse-grained sands, medium to coarse grained sands, medium grained sands, medium to fine grained sands, sandy clay, silty clay, clayey sands, and organic clay.

The Project site is a reclaimed sand-filled area. The stratigraphic units in the area comprises of:

- **Layer 1**: Medium grained sands and medium to coarse grained sandy soils occupying between 4.50 m to 7.0 m below ground surface. This area is a sand-filled area, and the thickness of the sand-filled area decreases away from the shoreline.
- **Layer 2**: Underlying layer 1 is a thick layer of silty clay and organic clay which stretches to a depth between 12.0 m and 14.0 m. The 7.0 m thick layer of clayey soils extends throughout the entire area and acts as a barrier that impedes surface infiltration from entering the subsurface environment.
- **Layer 3**: The thick clay layer is underlain by a continuous layer of sandy clay which extends to a depth ranging from 17.0 m to 20.0 m.
- **Layer 4**: Layer 3 is underlain by medium sands, medium to coarse sands and coarse sands to a depth of 30.0 m. This layer varies in thickness from 9.0 m to 11.0 m.

5.2.5.2 Proposed Project Activities

Construction Phase

Sources of impacts to the geology during the construction phase include:

- **Bored Piles Installation**: Bored piles will be installed through the soft and loose granular geology. Installation will involve installation of steel liners, drilling under bentonite slurry, sand separation, placement of steel reinforced cage into the drilled hole, concrete casting, and other tasks. Drilling, installation of the steel cage, and concrete casting will impact the geology of the site.

- **Construction of Surface Infrastructure**: Surface infrastructure construction will mostly entail shallow excavation to establish foundations, which will not have a significant impact on the geology of the site. Infrastructure that will be constructed include:
- **Urea Handling**: truck unloading bays, an underground hopper (the depth of excavation for the underground hopper is not known and could have a greater impact on the geology), a warehouse, outtake system.
- **The Quay**: Establishment of a 250 x 25 m platform, conveyor, ship loader, fenders and bollards.
- **Ammonia Handling**: ammonia unloading station, 1 x storage tank with 25,000 MT capacity, flare stack, boil of gas unit, pumping station.
- **Jetty Top Side**: loading system for bulk urea, loading arm for ammonia.
- **Utilities and Other Facilities**: cooling water system, plant air, instrument air and nitrogen storage, electrical, water storage treatment and distribution, firefighting system, sewage treatment unit, workshops, storage areas, security, and administration buildings.
- **Dredging**: The berth pocket in front of the quay where the vessel will be moored, will be dredged to a depth of approximately 13 meters.
- **Water Supply Well Installation**: It is planned that a total of 2 water supply wells will be installed. Drilling of the wells will have a localised impact on the geology of the site.

Operational Phase

- **Dredging**: The berth pocket in front of the quay where the vessel will be moored, will be dredged to a depth of approximately 13 meters. Dredging will be maintained over the life of operations in response to sediment deposition by the Bonny River refilling the dredged area to continue allowing ships to berth safely.

5.2.5.3 Sensitive Receptors

There are no sensitive receptors associated with the geology of the Site.

5.2.5.4 Significance of Impacts (Pre-mitigation)

Construction Phases

The impacts on the geological environment during the construction phase are discussed below.

- **Bored Piles Installation**: Bored piles will be installed through the soft and loose granular geology. Installation will involve installation of steel liners, drilling under bentonite slurry, sand separation, placement of steel reinforced cage into the drilled hole, concrete casting, and other tasks. During drilling the sand layers that constitute the underlying geology will be disturbed where the piles are being installed. Sand separation will further disturb the geological sequence. Due to the localised nature of the drilling the impact will be a "**Minor Negative Impact**" pre-mitigation (refer to Table 5-29).

- **Construction of Surface Infrastructure**: Construction of the surface infrastructure will include shallow excavation to established foundations. In general, the foundation excavations are expected to be shallow, and will not have a significant impact on the geological environment. Note that the depth of excavation for the underground hopper is not known and could cause a greater disturbance of the geology. Overall, the impact of construction of surface infrastructure on the geology will be a "**Minor Negative Impact**" pre-mitigation (refer to Table 5-30).
- **Dredging**: The berth pocket in front of the quay where the vessel will be moored, will be dredged to a depth of approximately 13 meters. This will cause a localised impact on the geology in the immediate vicinity of the dredging operations, as the sand which forms the underlying geology is excavated. On a catchment scale the impact of dredging on the geology will be a "**Minor Negative Impact**" pre-mitigation (refer to Table 5-31).
- **Water Supply Well Installation**: It is planned that a total of 2 water supply wells will be installed. Drilling of the wells will disturb the geology in the immediate area where the wells are drilled. The depth of the wells, and thus the depth of disturbance is not currently known. The impact of water well installation on the geology will be a "**Minor Negative Impact**" pre-mitigation (refer to Table 5-32).

Table 5-29: Rating of Impacts Related to Bored Piles Installation on the Geology during the and Construction Phase (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The disturbance to the geology will be limited to the immediate area where the piles are installed.
Duration	Permanent	The piles won't be removed; therefore, the impact is permanent.
Scale	± 10 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Once-off	The piles will only be installed once.
Magnitude		
Small Magnitude		

Sensitivity/Vulnerability/Importance of the Resource/Receptor
Low Sensitivity
The geology of the site has a low sensitivity.
Significant Rating Before Mitigation
Minor Impact

Table 5-30: Rating of Impacts Related to Surface Infrastructure Installation on the Geology during the Construction Phase (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The disturbance to the geology will be limited to the immediate area where the surface infrastructure is built.
Duration	Permanent	Any disturbance will be permanent as the buildings won't be removed.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Once-off	The surface infrastructure will only be built once.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		
The geology of the site has a low sensitivity.		
Significant Rating Before Mitigation		
Minor Impact		

Table 5-31: Rating of Impacts Related to Dredging on the Geology during the Construction Phase (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The disturbance to the geology will be limited to the immediate area where the dredging will be done.
Duration	Long-term	Any disturbance will be long-term as the dredging will be maintained until closure after which sand build-up in the quay area will resume due to continuous sediment deposition in the Boony River.

Scale	± 450 m	The quay area measures around 450 m.
Frequency	Intermittent	The dredging will be done once during construction, but will be maintained during the operational phase as and when required.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		
The geology of the site has a low sensitivity.		
Significant Rating Before Mitigation		
Minor Impact		

Table 5-32: Rating of Impacts Related to Water Supply Wells Installation on the Geology during the Construction Phase (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The disturbance to the geology will be limited to the immediate area where the wells are drilled. The wells will be relatively small diameter (likely less than 10” diameter).
Duration	Permanent	Any disturbance will be permanent as the wells won’t be removed.
Scale	± 10 m around each well	The wells will be likely be less than 10” diameter. Some disturbance of the surrounding sand can occur within a very small radius.
Frequency	Once-off	The wells will only be installed once.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		
The geology of the site has a low sensitivity.		
Significant Rating Before Mitigation		
Minor Impact		

Operational Phase

The impacts on the geological environment during the operational phase are discussed below.

- **Dredging**: The berth pocket in front of the quay where the vessel will be moored will be dredged to a depth of approximately 13 meters. Dredging will be maintained over the life of operations in response to sediment deposition by the Bonny River refilling the dredged area to continue allowing ships to berth safely. This will cause a localised impact on the geology in the immediate vicinity of the dredging operations. On a catchment scale the impact of dredging on the geology will be a "**Minor Negative Impact**" pre-mitigation (refer to Table 5-33*)*.

Table 5-33: Rating of Impacts Related to Dredging on the Geology during the Operational Phase (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The disturbance to the geology will be limited to the immediate area where the dredging will be done.
Duration	Long-term	Any disturbance will be long-term as the dredging will be maintained until closure after which sand build-up in the quay area will resume due to continuous sediment deposition in the Boony River.
Scale	± 5 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Intermittent	The dredging will be maintained during the operational phase as and when required.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		
The geology of the site has a low sensitivity.		
Significant Rating Before Mitigation		
Minor Impact		

5.2.5.5 Residual Impact (Post-mitigation)

Construction Phase

The significance ratings of residual impacts during the construction phase are as follows:

- **Bored Piles Installation**: The impact is already rated as a "minor" impact before mitigation and the reduction in the impacted area is not considered sufficient to reduce the impact rating to "negligible". Therefore, the impact is still rated to be a "**Minor Negative Impact**" (refer to Table 5-34).

- **Construction of Surface Infrastructure**: The post-mitigation significance associated with the construction of surface infrastructure on the geology is rated as being a "**Negligible Negative Impact**" (refer to Table 5-35).
- **Dredging**: On a catchment scale the impact of dredging on the geology is rated a "minor" impact pre-mitigation, and the rating is maintained as a "**Minor Negative Impact**" post-mitigation (refer to Table 5-36).
- **Water Supply Well Installation**: The impact of water well installation on the geology will remain rated as a "**Minor Negative Impact**" post-mitigation (refer to Table 5-37)

Table 5-34: Rating of Impacts Related to Bored Piles Installation on the Geology during the Construction Phase (Post-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The disturbance to the geology will be limited to the immediate area where the piles are installed.
Duration	Permanent	The piles won't be removed; therefore, the impact is permanent.
Scale	± 10 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Once-off	The piles will only be installed once.
Magnitude		
Small Magnitude		
Significant Rating Before Mitigation		
Minor Impact		

Table 5-35: Rating of Impacts Related to Surface Infrastructure Installation on the Geology during the Construction Phase (Post-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The disturbance to the geology will be limited to the immediate area where the surface infrastructure is built.
Duration	Permanent	Any disturbance will be permanent as the buildings won't be removed.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.

Frequency	Once-off	The piles will only be installed once.
Magnitude		
Small Magnitude		
Significant Rating Before Mitigation		
Minor Impact		

Table 5-36: Rating of Impacts Related to Dredging on the Geology during the Construction Phase (Post-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The disturbance to the geology will be limited to the immediate area where the dredging will be done.
Duration	Long-term	Any disturbance will be long-term as the dredging will be maintained until closure after which sand build-up in the quay area will resume due to continuous sediment deposition in the Boony River.
Scale	± 5 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Intermittent	The dredging will be done once during construction, but will be maintained during the operational phase as and when required.
Magnitude		
Small Magnitude		
Significant Rating Before Mitigation		
Minor Impact		

Table 5-37: Rating of Impacts Related to Water Supply Wells Installation on the Geology during the Pre-Construction and Construction Phases (Post-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The disturbance to the geology will be limited to the immediate area where the wells are drilled. The wells will be relatively small diameter (likely less than 10” diameter).
Duration	Permanent	Any disturbance will be long-term as the wells won’t be removed.
Scale	± 10 m around each well	The wells will be likely be less than 10” diameter. Some disturbance of the surrounding sand can occur within a very small radius.

Frequency	Once-off	The wells will only be installed once.
Magnitude		
Small Magnitude		
Significant Rating Before Mitigation		
Minor Impact		

Operational Phase

The significance rating of residual impact during the operational phase is as follows:

- **Dredging**: On a catchment scale the impact of dredging on the geology is rated a "minor" impact pre-mitigation, and the rating is maintained as a "**Minor Negative Impact**" post-mitigation (refer to Table 5-38).

Table 5-38: Rating of Impacts Related to Dredging on the Geology during the Operational Phase (Post-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The disturbance to the geology will be limited to the immediate area where the dredging will be done.
Duration	Long-term	Any disturbance will be long-term as the dredging will be maintained until closure after which sand build-up in the quay area will resume due to continuous sediment deposition in the Boony River.
Scale	± 5 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Intermittent	The dredging will be maintained during the operational phase as and when required.
Magnitude		
Small Magnitude		
Significant Rating Before Mitigation		
Minor Impact		

5.2.6 Soils and Land Use Impact Assessment

5.2.6.1 Description of the Baseline Environment

The soils of the region are classified as coastal plain sand (ultisoil), friable when dry and sticky when wet. The soil of the Project site is reclaimed with river sand, which dominates soil aggregates, making it friable both at wet and dry.

The porosity values for the topsoil on site range between 37.30 to 41.00 and 36.80 to 40.20% for subsoil, indicating varying levels of pore space within the soil samples, thus indicating soil capability to encourage good soil aeration. The soil texture within and around the Project site is classified as a sandy soil based on the high percentage of sand (83.28 - 86.54% and 82.64 - 86.72% for topsoil and subsoil respectively). The pH values range between 6.00 to 7.40 and 5.80 to 7.50 for subsoil indicating a slightly acidic to alkaline soil. Results from the heavy metals analyses showed heavy metal concentrations which are typical of the Niger Delta soil environment, indicating no form of pollution. Hydrocarbon analysis showed low concentrations with THC concentrations of between 0.75 - 2.46 mg/kg and 0.65 - 1.75 mg/kg for topsoil and subsoil respectively, indicating that the hydrocarbon source is biogenic.

The Onne Port complex was acquired by the Nigerian Government years back to foster industrialisation and also to enable international trade via water ways. Currently, the port complex plays host to over two hundred companies. Consequently, the entire port complex is designated as an industrial area to aid international business transaction. The closest community within the Port complex is the Onne and Ogu Community. The Ogu community is located across Bonny River. The Onne Community is largely a residential area and is 90% built up, while the Ogu communities are fishing settlements with the majority of the buildings being temporary structures.

As the population has grown over the period 2006 – 2019, the largest change in land use has been the built-up area, increasing from approximately 19 km^2 in 2006 to 49 km^2 in 2019. The increase in built-up land area has resulted in a decrease in land area covered by vegetation from approximately 93 km^2 in 2006 to 60 km^2 in 2019 (combined light and thick vegetation area).

5.2.6.2 Proposed Project Activities

Construction Phase

Sources of impacts to the soils and land use during the construction phase include:

- **Bored Piles Installation**: Bored piles will be installed through the soft and loose granular geology. Installation will involve installation of steel liners, drilling under bentonite slurry, sand separation, placement of steel reinforced cage into the drilled hole, concrete casting, and other tasks. Drilling, installation of the steel cage, and concrete casting will impact the soils of the site by disturbance of the soil structure (compaction of surface soil by vehicles or loosening of the structure due to drilling).

- **Construction of Surface Infrastructure**: Surface infrastructure construction will mostly entail shallow excavation to establish foundations, which will have a moderate impact on the soils and land use of the site. Infrastructure that will be constructed include:
- **Urea handling**: truck unloading bays, an underground hopper, a warehouse, outtake system.
- **The Quay**: Establishment of a 250 x 25 m platform, conveyor, ship loader, fenders and bollards.
- **Ammonia Handling**: ammonia unloading station, 1 x storage tank with 25,000 MT capacity, flare stack, boil of gas unit, pumping station.
- **Jetty Top Side**: loading system for bulk urea, loading arm for ammonia.
- **Utilities and Other Facilities**: cooling water system, plant air, instrument air and nitrogen storage, electrical, water storage treatment and distribution, firefighting system, sewage treatment unit, workshops, storage areas, security, and administration buildings.
- **Roads**: Roads will be constructed.
- **Water Supply Well Installation**: It is planned that a total of two water supply wells will be installed. Drilling of the wells will have a localised impact on the soils and land use of the site.
- **Vehicular Activity on Site**: increased vehicular activity on site can impact the soil:
- The surface soil can be compacted by increased vehicular activity on unpaved areas.
- Hydrocarbon spills from vehicles can contaminate the soil.

Operational Phase

- Increased vehicular activity on the site can cause:
- The surface soil can be compacted by increased vehicular activity on unpaved areas.
- Hydrocarbon spills from vehicles can contaminate the soil.

5.2.6.3 Sensitive Receptors

Sensitive receptors associated with the soil include:

- The underlying aquifers:
- Contamination entering the soil can migrate vertically to reach the water table.
- Compaction of the surface soil by vehicular activity can reduce rainfall recharge into the soil, and therefore, recharge into the underlying aquifers.
- The Bonny River:
- Increased compaction of the soil can increase surface runoff into the Bonny River during rainfall events, which will increase the river flow volume.
- Loosening of the soil during installation of the bored piles and shallow excavations during construction of surface infrastructure can lead to increased erosion which will increase sedimentation in the Bonny River.

5.2.6.4 Significance of Impacts (Pre-mitigation)

Construction Phase

The impacts on the soils and land use environment during the construction phase.

Please note: As part of the Onne Port complex, which contains more than two hundred companies, the property is designated as an industrial area. The Onno Port Complex has been zoned as an industrial area for years and access is controlled. No land use change is discussed below because the land use was formally changed years ago.

Impacts on soils during the construction phase include:

- **Bored Piles Installation**: Bored piles will be installed through the soft and loose granular sand. During drilling the soil will be disturbed where the piles are being installed. Due to the localised nature of the pile installation the impact will be a "**Minor Negative Impact**" pre-mitigation (refer to Table 5-39).
- **Construction of Surface Infrastructure**: Construction of the surface infrastructure will include shallow excavation to established foundations, which will negatively impact the soil structure. Surface soil can be compacted by increased vehicular activity, but will also be loosened by excavations. The loosening can lead to increased erosion during rainfall events. Overall, the impact of construction of surface infrastructure on the soil will be a "**Moderate Negative Impact**" pre-mitigation (refer to Table 5-40).
- **Water Supply Well Installation**: It is planned that a total of 2 water supply wells will be installed. Drilling of the wells will disturb the soil in the immediate vicinity of where the wells are drilled. The impact of water well installation on the soil will be a "**Minor Negative Impact**" pre-mitigation (refer to Table 5-41).
- **Vehicular Activity**: Soils can be impacted by vehicular activity on site during the construction phase:
- The surface soil can be compacted by increased vehicular activity on unpaved areas.
- Hydrocarbon spills from vehicles can contaminate the soil.
- The impact of water well installation on the soil will be a "**Minor Negative Impact**" pre-mitigation (refer to Table 5-42).

Table 5-39: Rating of Impacts Related to Bored Piles Installation on the Soils during the Construction Phase (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**

Extent	Local	The disturbance to the soils will be limited to the immediate area where the piles are installed.
Duration	Permanent	The piles won't be removed; therefore, the impact is permanent.
Scale	± 10 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Once-off	The piles will only be installed once.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
The soils of the site have a medium sensitivity. Disturbance of the soil can lead to increased erosion, and contamination from surface can migrate towards the water table where it joins the saturated zone.		
Significant Rating Before Mitigation		
Minor Impact		

Table 5-40: Rating of Impacts Related to Surface Infrastructure Installation on the Soils during the Construction Phase (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The disturbance to the soil will be limited to the immediate area where the surface infrastructure is built.
Duration	Permanent	Any disturbance will be permanent as the buildings won't be removed.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Once-off	The surface infrastructure will only be built once.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
The soils of the site have a medium sensitivity. Disturbance of the soil can lead to increased erosion, and contamination from surface can migrate towards the water table where it joins the saturated zone.		
Significant Rating Before Mitigation		
Moderate Impact		

Table 5-41: Rating of Impacts Related to Water Supply Wells Installation on the Soils during the Construction Phase (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The disturbance to the soils will be limited to the immediate area where the wells are drilled. The wells will be relatively small diameter (likely less than 10” diameter), while the drill pads will have footprint of less than 50 m radius.
Duration	Permanent	Any disturbance will be permanent as the wells won’t be removed.
Scale	± 50 m radius around each well	The drill pads will have footprint of less than 50 m radius.
Frequency	Once-off	The wells will only be installed once.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
The soils of the site have a medium sensitivity. Disturbance of the soil can lead to increased erosion, and contamination from surface can migrate towards the water table where it joins the saturated zone.		
Significant Rating Before Mitigation		
Minor Impact		

Table 5-42: Rating of Impacts Related to Vehicular Use on the Soils during the Construction Phase (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The disturbance to the soil can be within the entire property that is being developed.
Duration	Long-term	Any disturbance will be long-term as it can occur from pre-construction and construction phase to end of life of operations.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Daily	Vehicular activity can be daily.
Magnitude		

Small Magnitude
Sensitivity/Vulnerability/Importance of the Resource/Receptor
Medium Sensitivity
The soils of the site have a medium sensitivity. Compaction of the soil can lead to decreased recharge from rainfall into the soil, and contamination from surface can migrate towards the water table where it joins the saturated zone.
Significant Rating Before Mitigation
Minor Impact

Operational Phase

The impacts on the soils within the property being developed during the operational phase are discussed below.

- **Vehicular Activity**: Soils can be impacted by vehicular activity on site during the operations phase:
- The surface soil can be compacted by increased vehicular activity on unpaved areas.
- Hydrocarbon spills from vehicles can contaminate the soil.

The impact on soils during the operations phase will be a "**Minor Negative Impact**" pre-mitigation (refer to Table 5-43).

Table 5-43: Rating of Impacts Related to Vehicular Use on the Soils during the Operational Phase (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The disturbance to the soil can be within the entire property that is being developed.
Duration	Long-term	Any disturbance will be long-term as it can occur from pre-construction and construction phase to end of life of operations.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Daily	Vehicular activity can be daily.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
The soils of the site have a medium sensitivity. Compaction of the soil can lead to decreased recharge from rainfall into the soil, and contamination from surface can migrate towards the water table where it joins the saturated zone.		

Significant Rating Before Mitigation
Minor Impact

5.2.6.5 Residual Impact (Post-mitigation)

Construction Phase

The significance rating of residual impacts during the construction phase are as follows:

- **Bored Piles Installation**: The impact is already rated as a “minor” impact before mitigation and the reduction in the impacted area is not considered sufficient to reduce the impact rating to “negligible”. Therefore, the impact post-mitigation is still rated to be a “**Minor Negative Impact**” (refer to Table 5-44).
- **Construction of Surface Infrastructure**: Overall, the impact of construction of surface infrastructure on the soil is rated to be a “moderate” impact before mitigation. The rating post-mitigation remains “**Moderate Negative Impact**” (refer to Table 5-45).
- **Water Supply Well Installation**: The impact of water well installation on the soil will remain rated as a “**Minor Negative Impact**” post-mitigation (refer to Table 5-46).
- **Vehicular Use**: the impact of vehicular use on the soil is rated to be a “minor” impact before mitigation. The rating post-mitigation remains “**Minor Negative Impact**” (refer to Table 5-47).

Table 5-44: Rating of Impacts Related to Bored Piles Installation on the Soils during the Construction Phase (Post-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The disturbance to the soils will be limited to the immediate area where the piles are installed.
Duration	Permanent	The piles won’t be removed; therefore, the impact is permanent.
Scale	± 10 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Once-off	The piles will only be installed once.
Magnitude		
Small Magnitude		
Significant Rating Before Mitigation		
Minor Impact		

Table 5-45: Rating of Impacts Related to Surface Infrastructure Installation on the Soils during the Construction Phase (Post-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The disturbance to the soil will be limited to the immediate area where the surface infrastructure is built.
Duration	Permanent	Any disturbance will be permanent as the buildings won't be removed.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Once-off	The surface infrastructure will only be built once.
Magnitude		
Small Magnitude		
Significant Rating Before Mitigation		
Moderate Impact		

Table 5-46: Rating of Impacts Related to Water Supply Wells Installation on the Soils during the Construction Phase (Post-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The disturbance to the soils will be limited to the immediate area where the wells are drilled. The wells will be relatively small diameter (likely less than 10" diameter), while the drill pads will have footprint of less than 50 m radius.
Duration	Permanent	Any disturbance will be permanent as the wells won't be removed.
Scale	± 50 m radius around each well	The drill pads will have footprint of less than 50 m radius.
Frequency	Once-off	The wells will only be installed once.
Magnitude		
Small Magnitude		
Significant Rating Before Mitigation		
Minor Impact		

Table 5-47: Rating of Impacts Related to Vehicular Use on the Soils during the Construction Phase (Post-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The disturbance to the soil can be within the entire property that is being developed.
Duration	Long-term	Any disturbance will be long-term as it can occur from pre-construction and construction phase to end of life of operations.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Daily	Vehicular activity can be daily.
Magnitude		
Small Magnitude		
Significant Rating Before Mitigation		
Minor Impact		

Operational Phase

The significance rating of residual impact during the construction phase is as follows:

- **Vehicular Use**: the impact of vehicular use on the soil is rated to be a "minor" impact before mitigation. The rating post-mitigation remains "**Minor Negative Impact**" (refer to Table 5-48).

Table 5-48: Rating of Impacts Related to Vehicular Use on the Soils during the Operational Phase (Post-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The disturbance to the soil can be within the entire property that is being developed.
Duration	Long-term	Any disturbance will be long-term as it can occur from pre-construction and construction phase to end of life of operations.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Daily	Vehicular activity can be daily.
Magnitude		
Small Magnitude		

Significant Rating Before Mitigation
Minor Impact

5.2.7 Groundwater Impact Assessment

5.2.7.1 Description of the Baseline Environment

The main hydrogeological lithologies present in the study area are (i.) the Benin Formation which, together with the Akata and Agbada Formations, underlie the Niger Delta, and (ii) the Deltaic Formation.

The deltaic aquifer, which is the first and topmost groundwater unit recharged directly by infiltration from precipitation and baseflow, is classified as unconfined. The water table in the Niger Delta area is very close to the ground surface, ranging from 0 to 9 m below ground level. This area experiences limited water table fluctuation. Medium grained sands and medium to coarse grained sandy soils lies between 4.50 m to 7.0 m below ground surface. The sandy nature of the layer makes it permeable for surface water and potential contaminants to be transported into the aquifers. Underlying this layer is a thick layer of silty clay and organic clay which stretches to a depth between 12.0 m and 14.0 m. The 7.0 m thick layer of clayey soils extends throughout the entire area and acts as a barrier that impedes surface infiltration from entering the underlying aquifers.

The confined aquifers are confined by a clay bed up to 36 m thick. The confined aquifers can extend to 100 m below the confining layer. Moderately high-yielding artesian flows characterise these formations.

Groundwater flows from the northwestern part of the area towards the southeastern and southern part of the Project site. Although the localised groundwater flow direction trends towards the Bonny River, over-exploitation of wells within the area can cause a reversal in groundwater movement within the area.

The groundwater character in the area is consistently Na-Cl dominant. The groundwater is highly influenced by saline water intrusion into coastal aquifers.

5.2.7.2 Proposed Project Activities

Construction Phase

Sources of impacts to the groundwater resource during the construction phase include:

- **Groundwater Abstraction**: It is planned that two water supply wells will be installed. The abstracted groundwater will be stored in a storage tank of suitable capacity, from where the water will be supplied to the point of use. It is estimated that 10 m^3/day will be used for potable water, and 10 m^3/day for service water.
- **Bored Piles Installation**: Bored piles will be installed through the soft and loose granular geology. Installation will involve installation of steel liners, drilling under bentonite slurry, sand separation, placement of steel reinforced cage into the drilled hole, concrete casting, and other tasks Stabilising

muds, consisting of bentonite and water will be used. *Drilling, installation of the steel cage, and concrete casting can impact the groundwater flow patterns*. The source of water for the slurry and concrete casting is not known, and it is assumed that it will be sourced from the water supply wells on site, which *could lead to saltwater intrusion into the aquifers*.

- **Chemical and Hydrocarbon Spills**: During the construction phase, heavy machinery will be operational on site. There is a risk of impacts to the groundwater quality through accidental spills of fuels and oils, as well as other contaminants related to the transportation of equipment and materials during the construction phase. *The spill can enter the soil and migrate vertically into the underlying aquifers from where it will migrate away from site*.

Operational Phase

The sources of impacts during the operational phase can include:

- **Groundwater abstraction**: It is planned that two water supply wells will be installed. The abstracted groundwater will be stored in a storage tank of suitable capacity, from where the water will be supplied to the point of use. It is estimated that 10 m^3/day will be used for potable water, and 10 m^3/day for service water. *Abstraction of groundwater can lead to saltwater intrusion into the aquifers*.
- **Chemicals and Hydrocarbon Spills**: during the operational phase there is a risk of impacts to water quality through accidental spills of fuels and oils, as well as other contaminants related to the transportation of equipment and materials. Potential sources of contaminants include:
- Urea produced at the manufacturing site will be transported to the Terminal through covered tipper trucks having 40 MT payload capacity. Urea will be unloaded from the trucks. The unloaded urea passes through a grizzly (screen) and falls into underground hopper. The hopper bottom is fitted with belt conveyor through which the urea is conveyed to a bucket elevator. The bucket elevator conveys the urea to another belt conveyor at the top of urea warehouse. *During transport, unloading of the transport trucks, and conveying accidental spills could occur, which could impact the groundwater resource quality*.
- Ammonia produced at the manufacturing site will be transported to the Terminal by means of dedicated tankers. The ammonia will be unloaded & stored in an Ammonia Storage Tank for export. The design of ammonia Storage tank will be undertaken considering storage of ammonia at atmospheric pressure in refrigerated conditions. Accordingly, the tank will be double walled with inner insulation on outer wall, suspended deck with construction complying with latest edition of applicable standards. The storage tank will have all necessary instrumentation, Pressure Safety Valves (connected to Flare) and controls, over pressure and vacuum protection systems as applicable in accordance with SIL ratings. The liquid Ammonia from the storage tank will be transferred to the ship for export. A pumping station with interconnecting piping, requisite instrumentation and safety systems will be installed. *This is not seen to pose a significant risk of contamination to the groundwater resource.*

- The bulk urea will be loaded into the vessel by means of a travelling Ship-loader mounted on rails. The Ship-loader consists of a rail mounted travelling tripper-car housed in the quay conveyor which feeds the urea to a series of conveyors and a cascade chute through which urea gets loaded into the different hatches of the vessel without causing any damage to the urea granules. *This is not seen to pose a significant risk of contamination to the groundwater resource.*
- Sea water will be used for the fire water requirement of the terminal. Fire water pump house will be constructed near the shoreline. Sea water will be pumped from the fire water pumping station and distributed within the terminal area through underground / aboveground fire water piping network. *Use of the seawater during firefighting could impact the groundwater qualities in the underlying aquifers should excessive volumes of used seawater pond on surface and eventually recharge into the soils*.
- The sewage generated in the entire terminal area will be appropriately treated before discharging it outside of premises. A package sewage treatment unit of suitable size will be considered for treatment and disposal. *With proper design and maintenance this is not seen to pose a significant risk of contamination to the groundwater resource.*

5.2.7.3 Sensitive Receptors

Sensitive receptors include:

- The natural environment, including aquifers and surface water bodies present in the study area; and
- Human receptors, who are users of groundwater and surface water resources.

5.2.7.4 Significance of Impacts (Pre-mitigation)

Construction Phase

The impacts on the groundwater resource quality and quantity during the construction phase are discussed below.

- **Groundwater Abstraction**: As mentioned previously in this report, it is planned that two water supply wells will be installed. It is estimated that 10 m^3/day will be used for potable water, and 10 m^3/day for service water. These volumes are relatively low. However, abstraction of groundwater from these wells is expected lead to a potential drawdown in groundwater level in the surrounding aquifers, which in turn may lead to saltwater intrusion from the Bonny River. Sodium and chloride concentrations in the Bonny River is measured to range around 3,500 mg/L and 6,200 mg/L respectively, while the sodium and chloride concentrations in the aquifers are measured to be in the order of 10 – 280 mg/L and 20 – 700 mg/L respectively. Saltwater intrusion into an aquifer is almost impossible to mitigate and can have an impact on surrounding groundwater users as well. The impact from saltwater intrusion will be a "**<u>Major Negative Impact</u>**" pre-mitigation (refer to Table 5-49).

- **Bored Piles Installation**: Bored piles will be installed through the soft and loose granular geology. Installation will involve installation of steel liners, drilling under bentonite slurry, sand separation, placement of steel reinforced cage into the drilled hole, concrete casting, and other tasks. Groundwater flow patterns can be impacted:
- During drilling, should rotary air drilling methods be used, it is likely that groundwater will emerge on surface together with the drilled material. This can lead to a localised, small-scale drawdown in groundwater levels around the wells while drilling takes place. The impact on the groundwater levels will be very short duration and will disappear once drilling stops.
- Installation of steel cages and concrete casts will impact the groundwater flow patterns as the steel and concrete is impermeable and will cause groundwater flow to locally be diverted around the installations. This impact will be permanent as the infrastructure will not be removed.
- Impacts from bored piles installation will be a "**Minor Negative Impact**" pre-mitigation (refer to Table 5-50).
- **Chemical and Hydrocarbon Spills**: During the construction phase, heavy machinery will be operational on site. The spill can enter the soil and migrate vertically into the underlying aquifers from where it will migrate away from site. The extent and severity of these impacts are expected to be relatively low, but it is likely to remain in the soil and groundwater for a prolonged period. Remediation will be difficult. Impacts from chemical and hydrocarbon spills will be a "**Moderate Negative Impact**" pre-mitigation (refer to Table 5-51).

Table 5-49: Rating of Impacts Related to Saltwater Intrusion on the Groundwater Resource during the Construction Phase (Pre-Mitigation).

Type of Impact		
Induced Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The saltwater intrusion will be from the Bonny River towards the water supply wells.
Duration	Permanent	Once saltwater intrusion has occurred, it is almost impossible to mitigate.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Permanent	Once saltwater intrusion has occurred, it is almost impossible to mitigate.
Magnitude		
Large Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		

The groundwater resource in the vicinity of the site is not widely used for groundwater supply, in addition, based on the known groundwater qualities, there is already some saltwater intrusion that takes place. Therefore, natural and human receptors are not highly sensitive.
Significant Rating Before Mitigation
Major Impact

Table 5-50: Rating of Impacts Related to Bored Pile Installation on the Groundwater Resource during the Construction Phase (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The impact will be within the direct vicinity of the installed piles.
Duration	Permanent	The installation of the piles is permanent.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Permanent	The installation of the piles is permanent.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		
The aquifers are considered to have a low sensitivity to the small extent of impacts on groundwater flow patterns. There are no groundwater users within the vicinity that will be notably impacted.		
Significant Rating Before Mitigation		
Minor Impact		

Table 5-51: Rating of Impacts Related to Chemical and Hydrocarbon Spills on the Groundwater Resource during the Construction Phase (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The impact will be within the direct vicinity of the spills.
Duration	Permanent	Once contamination enters the aquifers remediation will be almost impossible.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.

Frequency	Permanent	Once contamination has occurred, it is almost impossible to mitigate
Likelihood	Possible	Spills are possible.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
The groundwater resource in the vicinity of the site is not widely used for groundwater supply, in addition, based on the known groundwater qualities, there is already some saltwater intrusion that takes place. Therefore, natural and human receptors are not highly sensitive.		
Significant Rating Before Mitigation		
Moderate Impact		

Operational Phase

The impacts on the groundwater resource quality and quantity during the operational phase are discussed below.

- **Groundwater Abstraction**: It is planned that two water supply wells will be installed. It is estimated that 10 m^3/day will be used for potable water, and 10 m^3/day for service water. These volumes are relatively low. However, abstraction of groundwater from these wells is expected lead to a potential drawdown in groundwater level in the surrounding aquifers, which in turn may lead to saltwater intrusion from the Bonny River. Sodium and chloride concentrations in the Bonny River is measured to range around 3,500 mg/L and 6,200 mg/L respectively, while the sodium and chloride concentrations in the aquifers are measured to be in the order of 10 – 280 mg/L and 20 – 700 mg/L respectively. Saltwater intrusion into an aquifer is almost impossible to mitigate and can have an impact on surrounding groundwater users as well. The impact from saltwater intrusion will be a "**Major Negative Impact**" pre-mitigation (refer to Table 5-52).
- **Chemicals and Hydrocarbon Spills**: During the operational phase there is a risk of impacts to water quality through accidental spills of fuels and oils, as well as other contaminants related to the transportation of equipment and materials.
- During transport, unloading of the transport trucks, and conveying of urea into the urea warehouse accidental spills could occur, which could impact the groundwater resource quality. The bulk urea will be loaded into the vessel by means of a travelling Ship-loader mounted on rails. The impact from transport, unloading, storage, and ship loading of urea is expected to be relatively small, depending on the volume of urea spilled. Depending on the frequency of spills the cumulative impact could increase in significance. The impact from urea on the groundwater resource will be a "**Moderate Negative Impact**" pre-mitigation (refer to Table 5-53).
- Ammonia produced at the manufacturing site will be transported to the Terminal by means of dedicated tankers and unloaded and stored in an Ammonia Storage Tank for export. The storage tank will be double walled, complying with latest edition of applicable standards. The storage tank

will have all necessary equipment and instrumentation as applicable in accordance with SIL ratings. The liquid Ammonia from the storage tank will be transferred to the ship for export via a pumping station with interconnecting piping, requisite instrumentation and safety systems will be installed. Assuming proper maintenance of the facilities and equipment, little impact from the ammonia on the groundwater resource is expected. The impact from ammonia on the groundwater resource will be a "**Moderate Negative Impact**" pre-mitigation (refer to Table 5-54).

- **Seawater for use as Fire Water**: Seawater will be used for the fire water requirement of the terminal. Use of the seawater during firefighting could impact the groundwater qualities in the underlying aquifers should excessive volumes of used seawater pond on surface and eventually recharge into the soils. The impact from the use of sea water as fire water on the groundwater resource will be a "**Minor Negative Impact**" pre-mitigation (refer to Table 5-55).
- **Sewage**: The sewage generated in the entire terminal area will be appropriately treated before discharging it outside of premises. A package sewage treatment unit of suitable size will be considered for treatment and disposal. With proper design and maintenance, the impact from sewage on the groundwater resource will be a "**Minor Negative Impact**" pre-mitigation (refer to Table 5-56).

Table 5-52: Rating of Impacts Related to Saltwater Intrusion on the Groundwater Resource during the Operational Phase (Pre-Mitigation).

Type of Impact		
Induced Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The saltwater intrusion will be from the Bonny River towards the water supply wells.
Duration	Permanent	Once saltwater intrusion has occurred, it is almost impossible to mitigate.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Permanent	Once saltwater intrusion has occurred, it is almost impossible to mitigate.
Magnitude		
Large Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
The groundwater resource in the vicinity of the site is not widely used for groundwater supply, in addition, based on the known groundwater qualities, there is already some saltwater intrusion that takes place. Therefore, natural and human receptors are not highly sensitive.		
Significant Rating Before Mitigation		
Major Impact		

Table 5-53: Rating of Impacts Related to Transport, Loading and Storage of Urea on the Groundwater Resource during the Operational Phase (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The impact will be within the direct vicinity of the spills.
Duration	Permanent	Once contamination enters the aquifers remediation will be almost impossible.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Permanent	Once contamination has occurred, it is almost impossible to mitigate
Likelihood	Possible	Spills are possible.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
The groundwater resource in the vicinity of the site is not widely used for groundwater supply, in addition, based on the known groundwater qualities, there is already some saltwater intrusion that takes place. Therefore, natural and human receptors are not highly sensitive.		
Significant Rating Before Mitigation		
Moderate Impact		

Table 5-54: Rating of Impacts Related to Transport, Loading and Storage of Ammonia on the Groundwater Resource during the Operational Phase (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The impact will be within the direct vicinity of the spills.
Duration	Permanent	Once contamination enters the aquifers remediation will be almost impossible.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Permanent	Once contamination has occurred, it is almost impossible to mitigate
Likelihood	Possible	Spills are possible.
Magnitude		
Medium Magnitude		

Sensitivity/Vulnerability/Importance of the Resource/Receptor
Medium Sensitivity
The groundwater resource in the vicinity of the site is not widely used for groundwater supply, in addition, based on the known groundwater qualities, there is already some saltwater intrusion that takes place. Therefore, natural and human receptors are not highly sensitive.
Significant Rating Before Mitigation
Moderate Impact

Table 5-55: Rating of Impacts Related to using Seawater as Fire Water on the Groundwater Resource during the Operational Phase (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The impact will be within the direct vicinity where seawater pond on surface.
Duration	Permanent	Once contamination enters the aquifers remediation will be almost impossible.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Permanent	Once contamination has occurred, it is almost impossible to mitigate
Magnitude		
Minor Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
The groundwater resource in the vicinity of the site is not widely used for groundwater supply, in addition, based on the known groundwater qualities, there is already some saltwater intrusion that takes place. Therefore, natural and human receptors are not highly sensitive.		
Significant Rating Before Mitigation		
Minor Impact		

Table 5-56: Rating of Impacts Related to Sewage on the Groundwater Resource during the Operational Phase (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The impact will be within the direct vicinity of the sewage leaks or spills.

Duration	Long term	Natural attenuation can reduce the impact.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Infrequent	A package sewage treatment unit of suitable size will be used for treatment and disposal. This will limit the frequency of contamination.
Likelihood	Possible	Spills are possible.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
The groundwater resource in the vicinity of the site is not widely used for groundwater supply, in addition, based on the known groundwater qualities, there is already some saltwater intrusion that takes place. Therefore, natural and human receptors are not highly sensitive.		
Significant Rating Before Mitigation		
Minor Impact		

5.2.7.5 Residual Impact (Post-mitigation)

Construction Phase

Based on the implementation of the proposed mitigation measures, the significance of the impact to the groundwater resource from the different impact sources will be reduced. Summaries of the different impacts post-mitigation are presented in Table 5-57 to Table 5-59. From the tables it can be seen that:

- Saltwater intrusion due to groundwater abstraction (Table 5-57) is reduced to a "**Moderate Negative Impact**". It should be noted that this is an estimate only. Aquifer test data on each of the water supply wells is required to assign a rating to this impact to a higher level of confidence. This information will be collected during well construction.
- The impact of bore pile installation can be reduced by limiting the area where bore piles are installed. This is already rated as a minor negative impact pre-mitigation and can be reduced further to a "**Negligible Negative Impact**" (Table 5-58).
- The impact of hydrocarbon and chemical spills can be reduced to a "**Minor Negative Impact**" (Table 5-59).

Table 5-57: Rating of Impacts Related to Saltwater Intrusion on the Groundwater Resource during the Construction Phase (Post-Mitigation).

Type of Impact
Induced Negative Impact
Rating of Impacts

Characteristic	Designation	Summary of Reasoning
Extent	Local	The saltwater intrusion will be from the Bonny River towards the water supply wells.
Duration	Permanent	Once saltwater intrusion has occurred, it is almost impossible to mitigate.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Permanent	Once saltwater intrusion has occurred, it is almost impossible to mitigate.
Likelihood	Unlikely	By positioning the wells as far from the Bonny River as possible, and by reducing the groundwater level drawdown, the likelihood of saltwater intrusion can be reduced or removed.
Magnitude		
Large Magnitude		
Significant Rating Before Mitigation		
Moderate Impact		

Table 5-58: Rating of Impacts Related to Bored Pile Installation on the Groundwater Resource during the Construction Phase (Post-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The impact will be within the direct vicinity of the installed piles.
Duration	Permanent	The installation of the piles is permanent.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Permanent	The installation of the piles is permanent.
Magnitude		
Small Magnitude		
Significant Rating Before Mitigation		
Negligible Impact		

Table 5-59: Rating of Impacts Related to Chemical and Hydrocarbon Spills on the Groundwater Resource during the Construction Phase (Post-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning

Extent	Local	The impact will be within the direct vicinity of the spills.
Duration	Permanent	Once contamination enters the aquifers remediation will be almost impossible.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Permanent	Once contamination has occurred, it is almost impossible to mitigate
Likelihood	Possible	Spills are possible.
Magnitude		
Medium Magnitude		
Significant Rating Before Mitigation		
Moderate Impact		

Operational Phase

Based on the implementation of the proposed mitigation measures, the significance of the impact to the groundwater resource from the different impact sources during the operational phase will be reduced. Summaries of the different impacts post-mitigation are presented in Table 5-60 to Table 5-64. From the tables it can be seen that:

- Saltwater intrusion due to groundwater abstraction (Table 5-60) is reduced to a "**Moderate Negative Impact**". It should be noted that this is an estimate only. Aquifer test data on each of the water supply wells is required to assign a rating to this impact to a higher level of confidence.
- The impact of hydrocarbon and chemical spills can be reduced adhering to good housekeeping and storing chemicals and hydrocarbons in suitable areas. This can be reduced to a "**Minor Negative Impact**" (Table 5-61 and Table 5-62).
- The impact of seawater being used as fire water will remain a "**Minor Negative Impact**" (Table 5-63).
- The impact from sewage will remain a "**Minor Negative Impact**" (Table 5-64).

Table 5-60: Rating of Impacts Related to Saltwater Intrusion on the Groundwater Resource during the Operational Phase (Post-Mitigation).

Type of Impact		
Induced Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The saltwater intrusion will be from the Bonny River towards the water supply wells.
Duration	Permanent	Once saltwater intrusion has occurred, it is almost impossible to mitigate.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.

Frequency	Permanent	Once saltwater intrusion has occurred, it is almost impossible to mitigate.
Likelihood	Unlikely	By positioning the wells as far from the Bonny River as possible, and by reducing the groundwater level drawdown, the likelihood of saltwater intrusion can be reduced or removed.
Magnitude		
Large Magnitude		
Significant Rating Before Mitigation		
Moderate Impact		

Table 5-61: Rating of Impacts Related to Transport, Loading and Storage of Urea on the Groundwater Resource during the Operational Phase (Post-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The impact will be within the direct vicinity of the spills.
Duration	Permanent	Once contamination enters the aquifers remediation will be almost impossible.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Permanent	Once contamination has occurred, it is almost impossible to mitigate
Likelihood	Possible	Spills are possible.
Magnitude		
Medium Magnitude		
Significant Rating Before Mitigation		
Moderate Impact		

Table 5-62: Rating of Impacts Related to Transport, Loading and Storage of Ammonia on the Groundwater Resource during the Operational Phase (Post-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The impact will be within the direct vicinity of the spills.
Duration	Permanent	Once contamination enters the aquifers remediation will be almost impossible.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.

Frequency	Permanent	Once contamination has occurred, it is almost impossible to mitigate
Likelihood	Possible	Spills are possible.
Magnitude		
Medium Magnitude		
Significant Rating Before Mitigation		
Moderate Impact		

Table 5-63: Rating of Impacts Related to using Seawater as Fire Water on the Groundwater Resource during the Operational Phase (Post-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The impact will be within the direct vicinity where seawater pond on surface.
Duration	Permanent	Once contamination enters the aquifers remediation will be almost impossible.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Permanent	Once contamination has occurred, it is almost impossible to mitigate
Magnitude		
Minor Magnitude		
Significant Rating Before Mitigation		
Minor Impact		

Table 5-64: Rating of Impacts Related to Sewage on the Groundwater Resource during the Operational Phase (Post-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The impact will be within the direct vicinity of the sewage leaks or spills.
Duration	Long term	Natural attenuation can reduce the impact.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Infrequent	A package sewage treatment unit of suitable size will be used for treatment and disposal. This will limit the frequency of contamination.

Likelihood	Possible	Spills are possible.
Magnitude		
Small Magnitude		
Significant Rating Before Mitigation		
Minor Impact		

5.2.8 Surface Water Impact Assessment

5.2.8.1 Description of the Baseline Environment

The sub-catchment within which the Site is located, is drained by the Bonny River, which forms the southern site boundary. To the east of the site, a channel to the Bonny River drains the area. Both the Bonny River and the channel is under tidal influence.

The Bonny River is characterised by deep and shallow channels with semi diurnal tides that generate tidal current in phase with the tidal direction. The morphology is shaped by high tidal oscillations superimposed on waves and sediments brought in by tributaries and creeks that flow into their drainage basins. The Bonny River is further characterised with strong currents, sandbars, and erosion. The land-water interchange is relatively extensive and more intimately connected with the surrounding land.

Bonny River is a brackish tidal water body which flows and ebbs in both directions into Bonny channel. During low tide the Bonny River flows in a south-westerly direction towards the ocean, while during high tide the river flow direction reverses to be northbound (inland) under tidal influence.

Numerous anthropogenic activities from oil and gas companies, import and export logistics, sand mining/dredging, and waste dumping are performed in and around the Bonny River. The flow rate of the Bonny Channel, which receives Atlantic Ocean water, has increased due to dredging which was both done to increase the depth of ship lines, and for shore reclamation. The flow rate is calculated to be between 0.9 and 1.5 m/s, with an average of 1.19 m/s.

Sodium and chloride concentrations in the Bonny River is measured to range around 3,500 mg/L and 6,200 mg/L respectively.

5.2.8.2 Proposed Project Activities

Construction Phase

Sources of impacts to the groundwater resource during the construction phase include:

- **Dredging**: The berth pocket in front of the quay where the vessel will be moored, will be dredged to a depth of approximately 13 meters.
- **Construction of Surface Infrastructure**:

- Surface infrastructure construction will lead to increased paved and roofed area, which will increase surface runoff during rainfall events and subsequently an increase in river flow volumes.
- Construction activities can result in silt laden surface water runoff that impact the river water quality.
- **Water Supply Well Installation and Groundwater Abstraction**: It is planned that a total of two water supply wells will be installed. Relatively small volumes of groundwater will be abstracted from these wells. Should the zone of influence of the groundwater level drawdown cone that develop around each of the wells reach the Bonny River, then some small quantities of stream water can be drawn towards the wells.
- **Increased Vehicular Movements**: Vehicle movements could decrease the quality of surface water runoff due to tyre wear particles, chemicals used in oils and lubricants, and spillage of fuels.
- **Impacts on Flood Risk** can originate from:
- Earthworks required to facilitate the Project, which will alter the topography of the local area. Any depressions created could facilitate stagnant pools of water following periods of heavy rainfall.
- Paving of the road surface, which will increase surface water runoff rates and velocities above the baseline. This has potential to negatively impact hydrologically connected downstream watercourses, and sensitive receptors immediately adjacent to the property.

Operational Phase

- **Dredging**: The berth pocket in front of the quay where the vessel will be moored, will be dredged to a depth of approximately 13 meters. The dredging will be maintained on an intermittent interval as required until the end of life of operations.
- **Water Supply Well Abstraction**: It is planned that a total of two water supply wells will be installed. Relatively small volumes of groundwater will be abstracted from these wells. Should the zone of influence of the groundwater level drawdown cone that develop around each of the wells reach the Bonny River, then some small quantities of stream water can be drawn towards the wells.
- **Increased Vehicular Movements**: increased movements could decrease the quality of surface water runoff due to tyre wear particles, chemicals used in oils and lubricants, and spillage of fuels.
- **Use of the Bonny River by Marine Vessels**: Vessels are required for export of the urea and ammonia products: Marine vessels will traverse the river and berth at the quay for export of the urea and ammonia products. Marine vessels can impact the surface water quality through spills of fuel, oils, paints, and cleansers.
- Sensitive Receptors

Sensitive receptors include:

- The natural environment, including the river, the ocean, and aquifers present in the study area; and
- Human receptors, who are users of surface water and groundwater resources.

5.2.8.3 Significance of Impacts (Pre-mitigation)

Construction Phase

The impacts on the surface water resource quality and quantity during the construction phase are discussed below.

- **Dredging**: The berth pocket in front of the quay where the vessel will be moored, will be dredged to a depth of approximately 13 meters. Impacts from dredging include:
    - Temporary increase in turbulence and suspended solids in the water.
    - Permanent change to the river channel shape, which will influence flow characteristics.
    - The area where dredging will take place is a small percentage (<1 %) of the total river channel area. The stream flow volumes are high with natural high suspended solids. There are also numerous other companies in the area that already does dredging / bed sweeping. Therefore, the impact from dredging is a "**Minor Negative Impact**" pre-mitigation (Table 5-65).
- **Construction of Surface Infrastructure**:
    - Surface infrastructure construction will lead to increased paved and roofed area, which will increase surface runoff during rainfall events and subsequently increase the river flow volumes.
    - Construction activities can result in silt laden surface water runoff that impact the river water quality.
    - The water of the Bonny River is currently (pre-development) characterised by high sediment loads due to the effect of high flows, the tidal effect causing tidal flows, strong interaction with land and ongoing dredging by other operations. Based on the high flows and the impacted quality, the impact from increased surface runoff and sediment load is considered to be a "**Minor Negative Impact**" pre-mitigation (Table 5-66).
- **Water Supply Well Installation and Groundwater Abstraction**: It is planned that a total of two water supply wells will be installed. Relatively small volumes of groundwater will be abstracted from these wells. Should the zone of influence of the groundwater level drawdown cone that develop around each of the wells reach the Bonny River, then some small quantities of stream water can be drawn towards the wells. The volume of water that could be drawn from the Bonny River towards the water supply wells is negligible compared to the total flow volume of the river. Therefore, the impact is rated as a "**Minor Negative Impact**" pre-mitigation (Table 5-67).
- **Impacts on Flood Risk** can originate from:
    - Earthworks required to facilitate the Project, which will alter the topography of the local area. Any depressions created could facilitate stagnant pools of water following periods of heavy rainfall.
    - Paving of the road surface which will increase surface water runoff rates and velocities above the baseline. This has potential to negatively impact hydrologically connected downstream watercourses, and sensitive receptors immediately adjacent to the property.

Taking into consideration the magnitude of the Bonny River and flow volumes, the impact of flood risk from the site to the Bonny River is considered to be a "**Negligible Negative Impact**" pre-mitigation (Table 5-68). However, the site could be at risk of flooding from the river.

Table 5-65: Rating of Impacts Related to Dredging on the Surface Water Resource during the Construction Phase (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The impact to the shape and flow characteristics of the river channel will be limited to the area where dredging takes place. The impact on the river sediment load will extend a distance down stream of where the dredging takes place. Note the downstream direction will change depending on the tidal effect.
Duration	Short-term (increased sediment load) Long-term (change to the river channel flow characteristics)	The increased sediment load will only be during the times that dredging takes place. Afterwards, when the disturbance of the riverbed ceases the sediments will settle. Dredging will be maintained during the life of operations to ensure safe berthing of marine vessels for the export of the urea and ammonia. After operations stop the dredging will stop and natural sedimentation of the riverbed will alter the shape and river flow characteristics.
Scale	450 m	The quay area is approximately 450 m long.
Frequency	Intermittent	The dredging will be done once during construction but will be maintained during the operational phase as and when required.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		
Due to the existing impacts on the Bonny River from other operations in the area, there is a low sensitivity to the relatively small additional impacts from the proposed operations.		
Significant Rating Before Mitigation		
Minor Impact		

Table 5-66: Rating of Impacts Related to Construction of Surface Infrastructure on the Surface Water Resource during the Construction Phase (Pre-Mitigation).

Type of Impact		
Induced Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning

Extent	Local	Surface runoff into from the site into the Bonny River will be directly down gradient of the site.
Duration	Short-term (increased sediment load) Long-term (increase in runoff during rainfall events)	The increased sediment load will only be during the construction phase. The installed paving and roof area will remain for the duration of operations.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Once-off	The surface infrastructure will only be built once.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		
Due to the existing impacts on the Bonny River from other operations in the area, there is a low sensitivity to the relatively small additional impacts from the proposed operations.		
Significant Rating Before Mitigation		
Minor Impact		

Table 5-67: Rating of Impacts Related to the Water Supply Wells on the Surface Water Resource during the Construction Phase (Pre-Mitigation).

Type of Impact		
Induced Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The zone of influence of the groundwater level drawdown cone will be in the direct vicinity of the wells. It is estimated to be less than 500 m.
Duration	Long-term	The water supply wells will be active until the end of operations
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Continuous	The zone of influence around the water supply wells will continue to exist until groundwater abstraction from the wells is stopped, which is assumed to be at the end of life of operations.
Likelihood	Possible	Whether this impact occurs depends on the water supply well position and the actual zone of influence of the groundwater level drawdown. Proper management of the abstraction wells could prevent this impact. Please refer to Chapter 5.6.6 for more information.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		

Due to the high flow volume in the Bonny River and the comparatively negligible volumes that could be drawn towards the water supply wells, there is a low sensitivity to the impact.	
Significant Rating Before Mitigation	
Minor Impact	

Table 5-68: Rating of Impacts Related to Flood Risk on the Surface Water Resource during the Construction Phase (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Surface runoff into from the site into the Bonny River will be directly down gradient of the site.
Duration	Short-term	Any flooding will occur during and directly after high rainfall events.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Intermittent	Any flooding will occur during and directly after high rainfall events.
Likelihood	Unlikely	The size of the Project area is not large enough to generate sufficient runoff to cause flooding of the Bonny River. There is a higher risk of flooding of the site from the Bonny River due to high rainfall events higherup in the catchment.
Magnitude		
Negligible Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		
Due to the high flow volume in the Bonny River and the comparatively small surface runoff volumes that could be generated from the site, there is a low sensitivity to the impact.		
Significant Rating Before Mitigation		
Negligible Impact		

Operational Phase

The impacts on the surface water resource quality and quantity during the operational phase are discussed below.

- **Dredging**: The berth pocket in front of the quay where the vessel will be moored, will be dredged to a depth of approximately 13 meters during construction. The dredging of the channel will be maintained during the life of operations to ensure safe berthing of the marine vessels for export of the urea and ammonia. Impacts from intermittent dredging to maintain the dredged channel include:
  - Temporary increase in turbulence and suspended solids in the water.
  - Permanent change to the river channel shape, which will influence flow characteristics.

- The area where dredging will take place is a small percentage (<1 %) of the total river channel area. The stream flow volumes are high with natural high suspended solids. There are also numerous other companies in the area that already does dredging / bed sweeping. Therefore, the impact from dredging is a "**Minor Negative Impact**" pre-mitigation (refer to Table 5-69).

- **Use of the Bonny River by Marine Vessels for Export of the Urea and Ammonia products**: Marine vessels will traverse the river and berth at the quay for export of the urea and ammonia products. Impacts from the vessels mostly relate to impacts on the river water quality due to spill of waste and hydrocarbons (fuel, oils, cleansers, paints). The river quality is already impacted by the numerous other marine vessels in that traverse the river. The impact from this is expected to be "**Minor Negative Impact**" pre-mitigation (refer to Table 5-70).
- **Groundwater Abstraction from the Water Supply Wells**: It is planned that a total of 2 water supply wells will be installed. Relatively small volumes of groundwater will be abstracted from these wells. Should the zone of influence of the groundwater level drawdown cone that develop around each of the wells reach the Bonny River, then some small quantities of stream water can be drawn towards the wells. The volume of water that could be drawn from the Bonny River towards the water supply wells is negligible compared to the total flow volume of the river. Therefore, the impact is rated as a "**Minor Negative Impact**" pre-mitigation (refer to Table 5-71).
- **Increased Vehicular Movements**: Increased movements could decrease the quality of surface water runoff due to tyre wear particles, chemicals used in oils and lubricants, and spillage of fuels. Numerous anthropogenic activities which include activities from oil and gas companies, import and export logistics, sand mining/dredging, are waste dumping already occur in and around the Bonny River, which impact the pre-development water quality. The impact is rated as a "**Minor Negative Impact**" pre-mitigation (refer to Table 5-72).
- **Impacts on Flood Risk** can originate from:
  - Earthworks required to facilitate the Project which will alter the topography of the local area. Any depressions created could facilitate stagnant pools of water following periods of heavy rainfall.
  - Paving of the road surface which will increase surface water runoff rates and velocities above the baseline. This has potential to negatively impact hydrologically connected downstream watercourses, and sensitive receptors immediately adjacent to the property.
- Taking into consideration the magnitude of the Bonny River and flow volumes, the impact of flood risk from the site to the Bonny River is considered to be a "**Negligible Negative Impact**" pre-mitigation (refer to Table 5-73). However, the site could be at risk of flooding from the river.

Table 5-69: Rating of Impacts Related to Dredging on the Surface Water Resource during the Operational Phase (Pre-Mitigation).

Type of Impact
Direct Negative Impact

Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The impact to the shape and flow characteristics of the river channel will be limited to the area where dredging takes place. The impact on the river sediment load will extend a distance down stream of where the dredging takes place. Note the downstream direction will change depending on the tidal effect.
Duration	Short-term (increased sediment load) Long-term (change to the river channel flow characteristics)	The increased sediment load will only be during the times that dredging takes place. Afterwards, when the disturbance of the riverbed ceases the sediments will settle. Dredging will be maintained during the life of operations to ensure safe berthing of marine vessels for the export of the urea and ammonia. After operations stop the dredging will stop and natural sedimentation of the riverbed will alter the shape and river flow characteristics.
Scale	450 m	The quay area is approximately 450 m long.
Frequency	Intermittent	The dredging will be maintained during the operational phase as and when required.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		
Due to the existing impacts on the Bonny River from other operations in the area, there is a low sensitivity to the relatively small additional impacts from the proposed operations.		
Significant Rating Before Mitigation		
Minor Impact		

Table 5-70: Rating of Impacts Related to Marine Vessels using the Bonny River on the Surface Water Resource during the Operational Phase (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Regional	The marine vessels will use the length of the Bonny River, from the ocean to the quay.
Duration	Long-term	The marine vessels will make use of the Bonny River until the end of operations.
Scale	Length of the Bonny River from the ocean to the quay.	The marine vessels will use the length of the Bonny River, from the ocean to the quay.

Frequency	Daily	The marine vessels will make daily use of the Bonny River.
Likelihood	Likely	Impacts to the river water quality is likely.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		
Due to the existing impacts on the Bonny River from other operations in the area, there is a low sensitivity to the relatively small additional impacts from the proposed operations.		
Significant Rating Before Mitigation		
Minor Impact		

Table 5-71: Rating of Impacts Related to the Groundwater Abstraction from Water Supply Wells on the Surface Water Resource during the Operational Phase (Pre-Mitigation).

Type of Impact		
Induced Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The zone of influence of the groundwater level drawdown cone will be in the direct vicinity of the wells. It is estimated to be less than 500 m.
Duration	Long-term	The water supply wells will be active until the end of operations
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Continuous	The zone of influence around the water supply wells will continue to exist until groundwater abstraction from the wells is stopped, which is assumed to be at the end of life of operations.
Likelihood	Possible	Whether this impact occurs depends on the water supply well position and the actual zone of influence of the groundwater level drawdown. Proper management of the abstraction wells could prevent this impact. Please refer to Chapter 5.6.6 for more information.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		
Due to the high flow volume in the Bonny River and the comparatively negligible volumes that could be drawn towards the water supply wells, there is a low sensitivity to the impact.		
Significant Rating Before Mitigation		
Minor Impact		

Table 5-72: Rating of Impacts Related to Vehicular Use on the Surface Water Resource during the Operational Phase (Pre-Mitigation).

Type of Impact		
Indirect Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The vehicle use relates to the proposed development property.
Duration	Long-term	The vehicle use will be until the end of life of operations.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Daily	Vehicle will be used daily.
Likelihood	Possible	Accidental spills and contamination is possible over the life of operations.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		
Due to the existing impacts on the Bonny River from other operations in the area, there is a low sensitivity to the relatively small additional impacts from the proposed operations.		
Significant Rating Before Mitigation		
Minor Impact		

Table 5-73: Rating of Impacts Related to Flood Risk on the Surface Water Resource during the Operational Phase (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Surface runoff into from the site into the Bonny River will be directly down gradient of the site.
Duration	Short-term	Any flooding will occur during and directly after high rainfall events.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Intermittent	Any flooding will occur during and directly after high rainfall events.
Likelihood	Unlikely	The size of the Project area is not large enough to generate sufficient runoff to cause flooding of the Bonny River. There is a higher risk of flooding of the site from the Bonny River due to high rainfall events higherup in the catchment.
Magnitude		

Negligible Magnitude
Sensitivity/Vulnerability/Importance of the Resource/Receptor
Low Sensitivity
Due to the high flow volume in the Bonny River and the comparatively small surface runoff volumes that could be generated from the site, there is a low sensitivity to the impact.
Significant Rating Before Mitigation
Negligible Impact

5.2.8.4 Residual Impact (Post-mitigation)

Construction Phase

The significance rating of residual impacts during the construction phase are as follows:

- **Dredging**: On a catchment scale the impact of dredging on the geology is rated a "minor" impact pre-mitigation, and the rating is maintained as a "**Minor Negative Impact**" post-mitigation (refer to Table 5-74)
- **Construction of Surface Infrastructure**: Overall, the impact of construction of surface infrastructure on the surface water resource is rated to be a "minor" impact before mitigation. The rating post-mitigation remains "**Minor Negative Impact**" (refer to Table 5-75)
- **Water Supply Well Installation and Groundwater Abstraction**: The impact is rated as a "**Minor Negative Impact**" pre-mitigation based on the large flow volume of the Bonny River compared to the volume of water that would be drawn from the Bonny River to the groundwater supply wells, and this rating is maintained post-mitigation (refer to Table 5-76).
- **Impacts on Flood Risk**: Taking into consideration the magnitude of the Bonny River and flow volumes, the impact of flood risk from the site to the Bonny River is considered to be a "**Negligible Negative Impact**" pre-mitigation, this rating is maintained post-mitigation (refer to *Table 5-77*). The site could be at risk of flooding from the river. The design and installation of storm water management infrastructure should also aim to protect the site from flooding form the Bonny River.

Table 5-74: Rating of Impacts Related to Dredging on the Surface Water Resource during the Construction Phase (Post-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The impact to the shape and flow characteristics of the river channel will be limited to the area where dredging takes place. The impact on the river sediment load will extend a distance down stream of where the

		dredging takes place. Note the downstream direction will change depending on the tidal effect.
Duration	Short-term (increased sediment load) Long-term (change to the river channel flow characteristics)	The increased sediment load will only be during the times that dredging takes place. Afterwards, when the disturbance of the riverbed ceases the sediments will settle. Dredging will be maintained during the life of operations to ensure safe berthing of marine vessels for the export of the urea and ammonia. After operations stop the dredging will stop and natural sedimentation of the riverbed will alter the shape and river flow characteristics.
Scale	450 m	The quay area is approximately 450 m long.
Frequency	Intermittent	The dredging will be done once during construction but will be maintained during the operational phase as and when required.
Magnitude		
Small Magnitude		
Significant Rating Before Mitigation		
Minor Impact		

Table 5-75: Rating of Impacts Related to Construction of Surface Infrastructure on the Surface Water Resource during the Construction Phase (Post-Mitigation).

Type of Impact		
Induced Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Surface runoff into from the site into the Bonny River will be directly down gradient of the site.
Duration	Short-term (increased sediment load) Long-term (increase in runoff during rainfall events)	The increased sediment load will only be during the construction phase. The installed paving and roof area will remain for the duration of operations.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Once-off	The surface infrastructure will only be built once.
Magnitude		
Small Magnitude		
Significant Rating Before Mitigation		
Minor Impact		

Table 5-76: Rating of Impacts Related to the Water Supply Wells on the Surface Water Resource during the Construction Phase (Post-Mitigation).

Type of Impact		
Induced Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The zone of influence of the groundwater level drawdown cone will be in the direct vicinity of the wells. It is estimated to be less than 500 m.
Duration	Long-term	The water supply wells will be active until the end of operations
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Continuous	The zone of influence around the water supply wells will continue to exist until groundwater abstraction from the wells is stopped, which is assumed to be at the end of life of operations.
Likelihood	Possible	Whether this impact occurs depends on the water supply well position and the actual zone of influence of the groundwater level drawdown. Proper management of the abstraction wells could prevent this impact. Please refer to Chapter 5.6.6 for more information.
Magnitude		
Small Magnitude		
Significant Rating Before Mitigation		
Minor Impact		

Table 5-77: Rating of Impacts Related to Flood Risk on the Surface Water Resource during the Construction Phase (Post-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Surface runoff into from the site into the Bonny River will be directly down gradient of the site.
Duration	Short-term	Any flooding will occur during and directly after high rainfall events.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Intermittent	Any flooding will occur during and directly after high rainfall events.
Likelihood	Unlikely	The size of the Project area is not large enough to generate sufficient runoff to cause flooding of the Bonny River. There is a higher risk of flooding of the site from the Bonny River due to high rainfall events higherup in the catchment.
Magnitude		

Negligible Magnitude
Significant Rating Before Mitigation
Negligible Impact

Operational Phase

The significance rating of residual impacts during the operations phase are as follows:

- **Dredging**: The impact from dredging is rated as a "**Minor Negative Impact**" pre-mitigation, and this is maintained post-mitigation (refer to *Table 5-78*).
- **Use of the Bonny River by Marine Vessels for Export of the Urea and Ammonia Products**: The impact from this is rated to be "**Minor Negative Impact**" pre-mitigation and could be reduced to a "**Negligible Negative Impact**" post-mitigation (refer to Table 5-79).
- **Groundwater Abstraction from the Water Supply Wells**: The impact is rated as a "**Minor Negative Impact**" pre-mitigation based on the large flow volume of the Bonny River compared to the volume of water that would be drawn from the Bonny River to the groundwater supply wells, and this rating is maintained post-mitigation (refer to Table 5-80).
- **Increased Vehicular Movements**: The impact is rated as a "**Minor Negative Impact**" pre-mitigation, and this rating is maintained post-mitigation (refer to Table 5-81).
- **Impacts on Flood Risk**: Taking into consideration the magnitude of the Bonny River and flow volumes, the impact of flood risk from the site to the Bonny River is considered to be a "**Negligible Negative Impact**" pre-mitigation (refer to Table 5-82), this rating is maintained post-mitigation. The site could be at risk of flooding from the river. The design and installation of storm water management infrastructure should also aim to protect the site from flooding form the Bonny River.

Table 5-78: Rating of Impacts Related to Dredging on the Surface Water Resource during the Operational Phase (Post-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The impact to the shape and flow characteristics of the river channel will be limited to the area where dredging takes place. The impact on the river sediment load will extend a distance down stream of where the dredging takes place. Note the downstream direction will change depending on the tidal effect.
Duration	Short-term (increased sediment load) Long-term (change to the	The increased sediment load will only be during the times that dredging takes place. Afterwards, when the disturbance of the riverbed ceases the sediments will settle. Dredging will be maintained during the life of operations to ensure safe berthing of marine vessels for the export of the urea and ammonia. After

	river channel flow characteristics)	operations stop the dredging will stop and natural sedimentation of the riverbed will alter the shape and river flow characteristics.
Scale	450 m	The quay area is approximately 450 m long.
Frequency	Intermittent	The dredging will be maintained during the operational phase as and when required.
Magnitude		
Small Magnitude		
Significant Rating Before Mitigation		
Minor Impact		

Table 5-79: Rating of Impacts Related to Marine Vessels using the Bonny River on the Surface Water Resource during the Operational Phase (Post-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Regional	The marine vessels will use the length of the Bonny River, from the ocean to the Indorama Meliora quay.
Duration	Long-term	The marine vessels will make use of the Bonny River until the end of operations.
Scale	Length of the Bonny River from the ocean to the quay.	The marine vessels will use the length of the Bonny River, from the ocean to the Indorama Meliora quay.
Frequency	Daily	The marine vessels will make daily use of the Bonny River.
Magnitude		
Small Magnitude		
Significant Rating Before Mitigation		
Minor Impact		

Table 5-80: Rating of Impacts Related to the Groundwater Abstraction from Water Supply Wells on the Surface Water Resource during the Operational Phase (Post-Mitigation).

Type of Impact		
Induced Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The zone of influence of the groundwater level drawdown cone will be in the direct vicinity of the wells. It is estimated to be less than 500 m.

Duration	Long-term	The water supply wells will be active until the end of operations
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Continuous	The zone of influence around the water supply wells will continue to exist until groundwater abstraction from the wells is stopped, which is assumed to be at the end of life of operations.
Likelihood	Possible	Whether this impact occurs depends on the water supply well position and the actual zone of influence of the groundwater level drawdown. Proper management of the abstraction wells could prevent this impact. Please refer to Chapter 5.6.6 for more information.
Magnitude		
Small Magnitude		
Significant Rating Before Mitigation		
Minor Impact		

Table 5-81: Rating of Impacts Related to Vehicular Use on the Surface Water Resource during the Operational Phase (Post-Mitigation).

Type of Impact		
Indirect Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The vehicle use relates to the proposed development property.
Duration	Long-term	The vehicle use will be until the end of life of operations.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Daily	Vehicle will be used daily.
Likelihood	Possible	Accidental spills and contamination is possible over the life of operations.
Magnitude		
Small Magnitude		
Significant Rating Before Mitigation		
Minor Impact		

Table 5-82: Rating of Impacts Related to Flood Risk on the Surface Water Resource during the Operational Phase (Post-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning

Extent	Local	Surface runoff into from the site into the Bonny River will be directly down gradient of the site.
Duration	Short-term	Any flooding will occur during and directly after high rainfall events.
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted.
Frequency	Intermittent	Any flooding will occur during and directly after high rainfall events.
Likelihood	Unlikely	The size of the Project area is not large enough to generate sufficient runoff to cause flooding of the Bonny River. There is a higher risk of flooding of the site from the Bonny River due to high rainfall events higherup in the catchment.
Magnitude		
Small Magnitude		
Significant Rating Before Mitigation		
Negligible Impact		

5.3 Impacts on Ecological Environment from Planned Activities

5.3.1 Impacts on Terrestrial Environment

5.3.1.1 Description of the Baseline Environment

The Project area falls entirely within the historical extent of mangrove swamps of the lower tidal floodplain of the Bonny River. However, much of vegetation present along the Bonny Channel and Port Onne appears to be secondary vegetation. The Project site itself has been entirely cleared of mangrove vegetation and reclaimed by filling in wetland habitats as early as 2013. The resultant sand-filled areas are currently dominated by a variable layer of grasses and sedges, with a patchy occurrence of alien invasive shrubs, mostly consisting of *Chromolaena odorata*. Along the shoreline's tidal plains, remnant patches of mangrove vegetation exist, again invaded by alien invasive species, of which *Nypa fruticans* is the most prevalent species.

Fauna frequenting the Project site is relatively low in diversity, dominated by birds, of which most are generalist species. Whilst the Endangered African Grey Parrot and Vulnerable Knobbed Hornbill were observed in close proximity of the Project site, no suitable habitat for foraging, roosting, or breeding exists on or immediately around the Project site. Mammal diversity records stemmed largely from information obtained from nearby communities, whilst herpetofaunal records and observations were low. Of the herpetofauna, the Vulnerable Marine Iguana was the only threatened species that could be confirmed, frequenting the shorelines. The Vulnerable African Dwarf Crocodile may be present, based on information from nearby communities, but was not sighted during the surveys.

An initial screening of potential critical habitat triggering species revealed that from the flora side, those would be mostly taller trees, whilst the presence of critical-habitat-triggering terrestrial fauna would largely depend on the presence of such tall stands of trees, which have not been present since the site and surrounding areas were cleared/reclaimed for development. Following these insights, no further critical habitat investigations were undertaken, as no terrestrial critical habitat is present on or within at least 2km of the Project site.

5.3.1.2 Area of Influence for the Terrestrial Biodiversity Impact Assessment

In order to assess the various impacts of the Project, the AoI for terrestrial biodiversity has been developed to help to describe the likely effects of impacts on terrestrial biodiversity receptors and ecosystem services. Effects extending beyond the Project footprint are likely due to various sources such as noise and vibration, potential effects on surrounding freshwater habitats (note that estuarine habitat and ecosystem services impacts are discussed under Section 5.3.2), light spill, emergency flaring, presence of the construction workforce, and the potential spread of invasive species and pathogens. Using a conservative approach and also guided by the noise and air quality assessment, potential adverse impacts (excluding extreme unforeseen events) may be noted up to 2km away from the Project Site. This has been taken as the absolute outer limit of the potential AoI considered for terrestrial biodiversity but limited to habitats outside the Bonny Channel and Port Onne.

5.3.1.3 Proposed Project Activities

5.3.1.3.1 Pre-Construction Phase

Sources of impacts to terrestrial biodiversity during the pre-construction phase include:

- Clearing and landscaping of the site of approximately 20 ha prior to construction, with complete loss of modified habitat on the Project site.
- Dredging, excavation and clearing of up to 400 m of the shoreline to allow building of the ± 300m quay structure, which may involve some clearing of remnant mangrove vegetation (including alien invasive species) at the interface between terrestrial and estuarine habitats.
- Chemical and hydrocarbon spills may arise from heavy machinery and vehicles operational on site.
- Some degree of dust emissions can be anticipated, as well as vehicle and machinery emissions.
- Littering and pollution may arise from inadequate waste disposal facilities and/or practices, as well as potential lack of adequate washrooms and associated facilities.
- Potential mortality and anticipated displacement of fauna.

5.3.1.3.2 Construction Phase

Sources of impacts to terrestrial biodiversity during the construction phase include:

- Construction activities, including introduction of materials.
- Installation of two water supply wells and associated storage tanks.
- Chemical and hydrocarbon spills may arise from heavy machinery and vehicles operational on site.
- Some degree of dust emissions can be anticipated, as well as vehicle and machinery emissions.

- Littering and pollution may arise from inadequate waste disposal facilities and/or practices, as well as potential lack of adequate washrooms and associated facilities.
- Potential mortality and anticipated displacement of fauna.
- Potential increased establishment or spread of alien invasive species.
- Potential indirect impacts on local biodiversity resulting from construction labour sourced from outside Port Onne communities, which are assumed to be largely outside the direct control of the Project.

5.3.1.3.3 Operational Phase

Sources of impacts to terrestrial biodiversity during the operational phase include:

- Chemical and hydrocarbon spills may arise from heavy machinery and vehicles operational on site (including workshops and maintenance areas); spills may also result from unforeseen events around the respective chemical and hydrocarbon storage systems.
- Storage and handling of urea and liquid ammonia (including emergency ammonia vapour flaring in case of any need) may pose the most significant impact on terrestrial biodiversity in case of an unforeseen event.
- In an unforeseen event of accidents or other along the existing transport routes from the production plant to the loading facility, spillages may also have a detrimental impact on biodiversity. This is briefly discussed, although this may occur outside the selected AoI.
- Power generation engines and associated exhausts, machinery and vehicles creating a continuous source of noise and emissions.
- Potential disturbance of fauna by high light levels
- Potential repeated dredging and related impacts on shorelines are covered in Section 5.3.2
- Waste disposal, including sewage treatment and subsequent discharge outside of premises.
- Potential increased establishment of alien invasive species.

5.3.1.4 Sensitive Receptors

The terrestrial biodiversity of the Project site is entirely modified, but still contains some indigenous flora and is frequented by a variable diversity of fauna, of which birds may likely are the most sensitive receptors. No suitable breeding or roosting habitat exists on the Project site for any threatened faunal species.

5.3.1.5 Significance of Impacts (Pre-mitigation)

Given the modified state of terrestrial habitats on the site and immediate surroundings, impacts during the pre-construction and construction phase are grouped together. In general, impacts will be divided into ‘Impacts on Indigenous Flora and Habitats’, and ‘Impacts on Indigenous Terrestrial Fauna and Avifauna’.

Pre-Construction and Construction Phase

<u>Impacts on indigenous flora and terrestrial habitats can be summarised as:</u>

- Direct destruction of modified habitats and their vegetation, and potential loss of seed-storing topsoil.
- Potential reduction in the extent of alien invasive plant species present on site, but conversely also the potential for further spread or re-establishment of such species on disturbed or sparsely vegetated and bare soils, also potential of increased alien invasive plant establishment on areas surrounding the Project site.
- If alien and invasive plant species are allowed to establish on topsoils and create soil seed banks, this will create the need to expensively remove such species and sterilize the soil before it can be used in any rehabilitation.
- Potential for accelerated (unnatural high levels of) erosion due to clearing of surfaces and shoreline dredging, most notable on small runoff drainages and the shoreline, which may contribute to further shoreline and mangrove habitat degradation.
- Reduced re-establishment potential of indigenous vegetation layer due to compaction and/or pollution of soils.
- Temporary smothering of plants with dust and associated retarded growth.
- Potential reduced resilience of remnant mangrove patches to persist or withstand invasion by alien plants.
- Potential damage of habitats and flora by pollution:
- Unchecked pollution and uncontained spillages will significantly damage the ecosystems they occur in. Pollutants may rapidly be distributed by leaching or runoff, contaminating water resources with associated added loss of biodiversity:
- Diesel and hazardous chemicals are extremely toxic to biodiversity – terrestrial and aquatic – and damage by spills may be extensive and spread beyond the AoI if not contained.
- Even small quantities of hydrocarbons and chemicals are able to pollute large quantities of soils and water and even if not spilled directly into water, will rapidly be transported to such by runoff or leaching though soils.
- Lack of adequate washrooms and the need to use the bush will increase the risk of spreading pathogens to the wider environment and facilitate the spread of undesirable insect capable of spreading pathogens further.

Based on the analysis provided above and considering the current ecological state of the site, the impact from pre-construction clearing and construction phase activities will be a "**Moderate Negative Impact"** pre-mitigation as set out below.

Table 5-83: Rating of Pre-construction and Construction Impacts on Indigenous Flora and Terrestrial Habitats (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Clearing and landscaping will be limited to the Project site and immediate shoreline
Duration	Short-term	Construction will be short-term
Scale	± 25 ha	This includes the site and immediate surroundings potentially impacted
Frequency	Ongoing	Prior to and during construction only, but anticipated to not exceed 18 months
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
Habitats and flora of the Project site is modified, but still contains some indigenous flora. Mangrove patches of medium sensitivity, despite being localised, are important for ecosystem services and ecosystem function, and under immense threat of alien invasive species and progressive clearing.		
Significance Rating Before Mitigation		
Moderate Significance		

<u>Impacts on indigenous terrestrial fauna, including avifauna, can be summarised as:</u>

- For fauna high noise levels, mainly from operating machinery and vehicles, can compromise predator/ prey detection and mating signals, may alter temporal or movement patterns and increase physiological stress. Combined, these impacts may lead to lower regeneration and loss of population viability.
- Loss of habitat and continued disturbance will displace fauna currently frequenting the Project site. However, fauna will be able to move to more natural habitats in close proximity.
- Air pollutants can create severe respiratory irritations and challenges to a host of fauna, of which birds and amphibians are likely the most sensitive. Reduced lung function can lead to illness, affect feeding, and cause reproductive loss. Due to the current low habitat value of the modified Project site and other alternatives being present for fauna, it is assumed that fauna will move away during high disturbance levels anticipated during the site preparations and construction.

- Fauna could be killed or injured due to vehicle collisions, entrapment on site (e.g., in excavations or fenced areas), uncontrolled spills of toxic substances (see below) and uncontrolled snaring/ hunting.
- Terrestrial fauna could be injured or lost due to coming into contact with electrical infrastructure, leading to electrocution death or some form of injury.
- Potential mortality or injury of fauna by pollution:
- Unchecked pollution by plastic or other materials may form death-traps to fauna trying to collect nesting material, possibly eat such or become entrapped in such waste, leading to a slow and agonizing death.
- Diesel and hazardous chemicals are extremely toxic to fauna – terrestrial and aquatic – and damage by spills may thus be extensive and spread beyond the AoI if not contained.
- Lack of adequate washrooms and the need to use the bush will increase the risk of exposing fauna to damaging pathogens, which can then be carried further by such fauna.
- Plastic and packaging waste as typically created by construction poses a high risk to fauna that may pick at such, try to eat it or collect it for nesting, eventually dying because of becoming entrapped, choking on it or due to ingestion.

Based on the analysis provided above and considering the current ecological state of the site, the impact from pre-construction clearing and construction phase activities will be a "**Moderate Negative Impact**" pre-mitigation as set out below.

Table 5-84: Rating of Pre-construction and Construction Impacts on Indigenous Terrestrial Fauna and Avifauna (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Regional	Clearing and landscaping will be limited to the Project site, but due to the mobility of fauna, the extent of negative impacts can be extended to the Region
Duration	Short-term	Construction will be short-term
Scale	± 22 ha	This includes the site and immediate surroundings potentially impacted
Frequency	Ongoing	Prior to and during construction only, but anticipated to not exceed 18 months
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		

Medium Sensitivity
Terrestrial habitats of the Project site are modified but is still frequented by a variable diversity of fauna. No suitable breeding or roosting habitat exists on the Project site for any threatened faunal species, although a few threatened faunal species have been observed flying over the site or frequenting the shoreline. However, fauna are mobile and as such can 'extend' the reach of the impacts.
Significance Rating Before Mitigation
Moderate Impact

Operational Phase

Impacts on indigenous flora and terrestrial habitats can be summarised as:

- Continued potential for further spread or re-establishment of alien invasive species on disturbed or sparsely vegetated and bare soils, also potential of increased alien invasive plant establishment on areas surrounding the Project site:
- Should on-site landscaping include non-indigenous plant species, such could 'escape' to the environment, contributing to increasing the pressure of alien invasive species on surrounding habitats.
- Sealed and bare surfaces produce much higher volumes of runoff, which typically flows much faster, loads more pollutants and bare soil, increases flooding risk and the risk of rapidly spreading any surface pollutants into surrounding areas and downstream aquatic environments. This results in pollution and sedimentation of such habitats potentially far beyond the Project site, potentially leading to significant loss of biodiversity as well as quality water that people depend on
- Loss of and degradation of habitat around the Project site will reduce the ability of ecosystems to filter, absorb and provide clean water.
- Potential reduced resilience of remnant mangrove patches to persist over the long term due to periodic dredging and ship movement.
- Potential damage by pollution, as follows:
- Unchecked pollution and uncontained spillages may significantly damage the ecosystems they occur in and may rapidly be distributed by leaching or runoff to contaminate water resources with associated added loss of biodiversity. Leaching of ammonia or urea into surroundings may significantly alter the natural dynamics, species composition and ecosystem function of vegetation in surrounding and downstream habitats.
- Diesel and hazardous chemicals are extremely toxic to biodiversity – terrestrial and aquatic – and damage by spills may thus be extensive and spread beyond the AoI if not contained.
- Even small quantities of hydrocarbons and chemicals are able to pollute very large quantities of soils and water and even if not spilled directly into water, will rapidly be transported to such by runoff or leaching though soils with an associated loss of vegetation and/or degradation of remnant on-site or surrounding habitats.

- Ammonia – despite being an important fertilizer to plants - is also a major source of nitrogen pollution, with nitrogen accumulation potentially having a massive impact on plant species diversity and composition. This may occur if even low amounts of ammonia vapour or urea dust escape intermittently or continually during operation. Over time, this may increasingly impact especially mangrove habitats, but also potentially greatly facilitate the establishment and damaging proliferation of alien invasive plants[6].

Based on the analysis provided above and assuming that no habitat will be left within the Project site after construction, the impact from Project operations will be a "**Moderate Negative Impact**" pre-mitigation as set out below.

Table 5-85: Rating of Operational Impacts on Indigenous Flora and Terrestrial Habitats (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Regional	Uncontained spillages and/or unfiltered runoff will impact an area possibly wider than the Project site or immediate surroundings. Unchecked spread of alien invasive plants will continually contribute to more reproductive material being spread in and beyond the AoI
Duration	Long-term	For as long as operations continue
Scale	± 25 ha or more	This includes immediate surroundings and potential downstream habitats potentially impacted. Unplanned events are discussed further below.
Frequency	Ongoing	For as long as operations continue
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
Terrestrial habitats of the Project site are modified and will be destroyed by construction. However, surrounding the Project site there is still natural habitats that could potentially be adversely affected should negative impacts manifest.		
Significance Rating Before Mitigation		
Moderate Significance		

[6] Guthrie, S., Harshfield, A., Ioppolo, B., Dunkerley, F., Manville, C., Tabaqchali, H., & Giles, S. (2018). Impact of ammonia emissions from agriculture on biodiversity: An evidence synthesis. Available from https://www.rand.org/pubs/research_reports/RR2695.html

Impacts on indigenous terrestrial fauna, including avifauna can be summarised as:

- Excessive light pollution disrupts the biological clock and associated physiological processes for many plants but especially animals, it affects interactions between species, and significantly alters energy expenditure in species leading to a loss of individual's fitness to reproduce.
- For fauna, high noise levels, mainly from operating machinery and vehicles, compromise predator/ prey detection and mating signals, alter temporal or movement patterns and increase physiological stress. Combined these impacts lead to lower regeneration and loss of population viability.
- Air pollutants can create severe respiratory irritations and challenges to a host of fauna, of which birds are likely the most sensitive. Reduced lung function can lead to illness, affect feeding, and cause reproductive loss. Due to the current low habitat value of the modified Project site and other alternatives being present for fauna, it is assumed that fauna will move away during high disturbance levels due to preparatory work and construction.
- Fauna could be killed or injured due to vehicle collisions or entrapment on site.
- Terrestrial fauna could be injured or lost due to coming in contact with electrical infrastructure, leading to electrocution death or some form of injury.
- Inadequate handling of organic waste, including inadequate sewage treatment, could expose fauna to harmful pathogens that could either kill such animals or be carried further by them. Some organic waste may also attract unwanted 'pest' flora, which could pose a risk to human health.
- Inadequate handling and disposal of plastic and packaging waste will pose a serious hazard to fauna collecting such for nesting, trying to eat it or becoming entrapped in it. As fauna may carry such materials to sites outside the AoI, this impact could reach beyond the AoI.
- Ammonia is found in relatively low nontoxic concentrations in soil, air, and water, but even low levels of ammonia can be highly toxic to any fauna.
- In the case of long-term impacts on flora inside and around the AoI, this will affect fauna as well due to change of available habitat and degradation of habitat quality.

Based on considerations provided above and considering after construction practically no vegetated habitat will exist on the Project site, the impact from Project operations will be a "**Moderate Negative Impact**" pre-mitigation as set out below

Table 5-86: Rating of Operational Impacts on Indigenous Terrestrial Fauna and Avifauna (Pre-Mitigation).

Type of Impact		
Direct Negative Impact and Indirect Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Regional	Uncontained spillages and/or unfiltered runoff will impact an area possibly wider than the Project site or immediate surroundings

		Unchecked spread of alien invasive plants will continually contribute to more reproductive material being spread in and beyond the AoI
Duration	Long-term	For as long as operations continue
Scale	± 25 ha or more	This includes immediate surroundings and potential downstream habitats potentially impacted. Unplanned events are discussed further below.
Frequency	Ongoing	For as long as operations continue
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
Habitats and flora of the Project site is modified and will likely be entirely cleared by the time operation starts. However, as fauna is mobile and even threatened fauna can still access or frequent the Project site and immediate surrounds during operation.		
Significance Rating Before Mitigation		
Moderate Significance		

5.3.1.6 Residual Impact (Post-mitigation)

Pre-Construction and Construction Phase

Based on the implementation of the proposed mitigation measures, the significance of the impact to Indigenous Flora and Terrestrial Habitats as well as Indigenous Terrestrial Fauna and Avifauna will be a "**Minor Negative**" post mitigation (Table 5-92).

Table 5-87: Rating of Residual Impacts Related to Indigenous Flora and Terrestrial Habitats (Post-Mitigation) during Pre-construction and Construction.

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Disturbances will be reduced to the smallest footprint possible, limited to the Project Site only
Duration	Short term	Pre-construction and construction activities are presumed to be completed within 18 to 24 months; however, the loss of habitat will be permanent (see frequency below)
Scale	± 20 ha	Limited to the Project Site only
Frequency	Permanent	Modification of the Project Site and quay will be permanent, unless demolition and decommissioning are foreseen at some stage
Likelihood	Likely	The Project cannot progress without the modification of the site
Magnitude		
Small Magnitude		

Significant Rating After Mitigation
Minor Impact

Table 5-88: Rating of Residual Impacts Related to Indigenous Terrestrial Fauna and Avifauna (Post-Mitigation) during Pre-construction and Construction.

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Disturbances will be reduced to the smallest footprint possible, whilst loss and injury of fauna can be avoided
Duration	Long-term	Pre-construction and construction activities are presumed to be completed within 18 to 24 months. Although some species may frequent the Project site again after completion of construction, the number and diversity of such is anticipated to be much lower due to loss of suitable habitat.
Scale	± 20 ha	Limited to the Project Site only
Frequency	Permanent	Modification of the Project Site and quay will be permanent, unless demolition and decommissioning are foreseen at some stage
Likelihood	Likely	The Project cannot progress without the modification of the site
Magnitude		
Small Magnitude		
Significant Rating After Mitigation		
Minor Impact		

Operational Phase

Based on the implementation of the proposed mitigation measures, the significance of the impact to Indigenous Flora and Terrestrial Habitats will be a "**Negligible Negative Impact**" post mitigation, whilst on Indigenous Terrestrial Fauna and Avifauna will remain a "**Minor Negative Impact**", mainly due to the mobility of fauna.

Table 5-89: Rating of Residual Impacts Related to Indigenous Flora and Terrestrial Habitats (Post-Mitigation) during Operation.

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Disturbances will be reduced to the smallest footprint possible, limited to the Project Site only
Duration	Short term	Pre-construction and construction activities are presumed to be completed within 18 to 24 months; however, the loss of habitat will be permanent (see frequency below)
Scale	± 20 ha	Limited to the Project Site only

Frequency	Permanent	Modification of the Project Site and quay will be permanent, unless demolition and decommissioning are foreseen at some stage
Likelihood	Low	Despite sensitivity of likely affected receptors remaining at least medium outside the Project site, with design concepts and mitigation the likelihood of adverse impacts is anticipated to be low, resulting in a negligible magnitude.
Magnitude		
Negligible Magnitude		
Significant Rating After Mitigation		
Negligible Impact		

Table 5-90: Rating of Residual Impacts Related to Indigenous Terrestrial Fauna and Avifauna (Post-Mitigation) during Operation.

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Disturbances will be reduced to the smallest footprint possible, whilst loss and injury of fauna can be avoided
Duration	Permanent	Although some species may frequent the Project site again after completion of construction, the number and diversity of such is anticipated to be much lower due to loss of suitable habitat. This displacement will continue as long as the Project site exists.
Scale	± 20 ha	Limited to the Project Site and immediate surroundings, the latter mainly due to ongoing disturbance levels of the Project activities.
Frequency	Ongoing	Faunal disturbance by the Project Site and quay will be ongoing, unless demolition and decommissioning are foreseen at some stage
Likelihood	Medium	Sensitivity of likely affected receptors remaining at least medium inside and outside the Project site, with design concepts and mitigation the likelihood of adverse impacts will still remain, unless operations seize. The magnitude of such disturbances, however, should be small.
Magnitude		
Small Magnitude		
Significant Rating After Mitigation		
Minor Impact		

5.3.1.7 Impacts from Unplanned Events

Impacts of unplanned events on terrestrial biodiversity collective can be summarised as follows:

- In the case of an unforeseen extreme events (e.g., flooding) or possibly machinery failure leading to higher volumes of hydrocarbon or ammonia and urea spills:
- Moderate to high volumes of hydrocarbons could be spilled on the site or quay, and rapidly move into water from where downstream or nearby habitats may be polluted, of which mangroves are

likely to be most impacted. This may cause a varying extent of plants and fauna to be killed off or suffer long-term degradation. Despite the Niger Delta being known to have indigenous hydrophilic micro-organism in its soil, these are naturally in too low densities to biodegrade hydrocarbons rapidly and are better adapted to digesting crude oil than refined hydrocarbons[7]. On average it takes in excess of fifteen years for mangroves to recover after a major oil spill, and it must be noted that hydrocarbons such as diesel as used by trucks or other machineries are more toxic to biodiversity than crude oil.

- Moderate to high volumes of ammonia and/or urea could be spilled and rapidly spread into surrounding habitats and/or be transported further by water. Ammonia and urea pollution impacts species composition through soil acidification, direct toxic damage to leaves and by altering the susceptibility of plants to heat, drought, and pathogens (including insect pests and invasive species). Unforeseen ammonia spills may severely damage crops and indigenous flora in the AoI by burning the leaves, and will be toxic to livestock and other fauna, especially aquatic fauna[8] (see *Section 5.7.2*).
- In the case of fire, it is anticipated that fauna locally present and not able to escape fast enough will be killed, whilst mangrove habitats on the shoreline may be severely scorched. Damage to terrestrial habitats in proximity and potential spread of fire will depend largely on the amount and type of vegetation present on surrounding (mostly modified) habitats, as well as wind speed and direction.
- Potential heat damage to vegetation on and surrounding the site if flaring is required.
- Emergency flaring – if required - may catch fauna unawares and cause injury or death, especially if this occurs at night, affecting fauna happening to be in close proximity to the flare stack. Escapes of ammonia vapours – with or without flaring, may also affect fauna (and potentially livestock) down-wind of the vapour escape or flare, depending on the magnitude of the event.

Table 5-91: Rating of Unforeseen Impacts on Terrestrial Biodiversity (Pre-Mitigation).

Type of Impact		
Direct and Indirect Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Regional	Uncontained large spillages will impact an area possibly wider than the Project site or immediate surroundings, although pollutants may be diluted rapidly A large fire event may impact habitats in the immediate surroundings but will most likely not spread to the entire 2km radius AoI

[7] Omenna, E. C., Omage, K., Ezaka, E., & Azeke, M. A. (2023). Tolerance, taxonomic and phylogenetic studies of some bacterial isolates involved in bioremediation of crude oil polluted soil in the southern region of Nigeria. Heliyon, 9(4), e15639. https://doi.org/10.1016/j.heliyon.2023.e15639

[8] Kelleghan, D.B., Fogarty, M., Welchman, S., Cummins, T., & Curran, T.P. (2022) Agricultural atmospheric ammonia: identification & assessment of potential impacts. Irish Wildlife Manuals, No. 135. National Parks and Wildlife Service, Department of Housing, Local Government and Heritage, Ireland.

Duration	Long-term	Ecosystems impacted may take in excess of ten years to recover, thus recovery will be slow and subject to no recurring or additional cumulative negative impacts
Scale	± 25 ha or more	This includes immediate surroundings and potential downstream habitats potentially impacted. The extent of impacted area will vary on the nature and severity of the unplanned event.
Consequence	Major	Impacts could lead to significant, widespread, and persistent changes in the abiotic environment leading to significant changes in habitat quality due to species die-off and/or long-term stunted growth of vegetation.
Likelihood	Low	The event is likely to occur at some time during normal operating conditions; likely to occur once or more in life of the project
Consequence		
Major Consequence		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium to High Sensitivity		
Impacts will likely manifest outside the Project site and potentially beyond the AoI, where natural and potentially much more sensitive habitats or species are anticipated.		
Significance Rating Before Mitigation		
Major Significance		

5.3.1.8 Residual Impacts of Unforeseen Events

Ideally, with the implementation of early warning and associated mitigation, residual impacts of unforeseen events can be reduced from a "**Major Negative Impact**" to at least "**Moderate Negative**" and optimally to "**Minor Negative Impact**". To predict the reduction of impact significance is, however, as difficult to predict as the nature and extent of an unplanned event.

Table 5-92: Rating of Unforeseen Impacts on Terrestrial Biodiversity (Post-Mitigation).

Type of Impact		
Direct and Indirect Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Regional	Rapidly contained large spillages will impact an area possibly wider than the Project site or immediate surroundings, although the aim will be to contain such at the spill site. A large fire event contained rapidly may impact habitats in the immediate surroundings but will most likely not spread to the entire 2km radius AoI, except for smoke-carried pollutants
Duration	Long-term	Ecosystems impacted may take in excess of ten years to recover, thus recovery will be slow and subject to no recurring or additional cumulative negative impacts.

Scale	± 25 ha or less	This includes immediate surroundings and potential downstream habitats potentially impacted. However, with rapid containment the extent of damaged ecosystems should be significantly lower and not extend to more than 100m outside the Project Area.
Consequence	Moderate	Impacts could lead to significant, localised (if rapidly contained) but persistent changes in the abiotic environment leading to changes in habitat quality due to species die-off and/or long-term stunted growth of vegetation.
Likelihood	Low	The event is likely to occur at some time during normal operating conditions; likely to occur once or more in life of the project
Consequence		
Moderate Consequence		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium to High Sensitivity		
Impacts will likely manifest outside the Project site and potentially beyond the AoI, where natural and potentially much more sensitive habitats or species are anticipated.		
Significance Rating After Mitigation		
Moderate Significance		

5.3.2 Impacts on Estuarine/ Aquatic Environment

5.3.2.1 *Description of the Baseline Environment*

The baseline study identified that while the aquatic biodiversity of the Project Area has been altered through anthropogenic impacts; the area does contain biodiversity of value. More detailed summaries of the baselines and associated impacts are provided in the respective impact assessments.

5.3.2.2 *Proposed Project Activities*

5.3.2.2.1 *Construction Phase*

The following types of potential impacts are considered during the construction phase:

- Direct loss of estuarine habitat and biota within the development footprint.
- Impacts of dredging, including increased turbidity, resuspension of pollutants, changes to the sediment profile, and impacts to estuarine habitat and biota downstream of the development.
- Disturbance to avifauna.
- Impacts of construction noise on estuarine biota.
- Changes in stormwater runoff.
- Changes in estuarine form and function.

5.3.2.2.2 *Operational Phase*

The following types of direct impacts are considered during the operational phase:

- Impacts of light on estuarine biota.
- Disturbance of avifauna.
- Impacts associated with increased vessel traffic, including the impacts of underwater noise on estuarine biota.
- Impacts associated with potential spillages during routine discharges from vessels by approved third parties.

5.3.2.3 *Sensitive Receptors*

The sensitive receptors in the area are estuarine organisms such as mangroves, benthic macrofauna, fish, birds, mammals, and reptiles, particularly the Endangered, Threatened and Protected Species outlined in Section 4.5.3 of the Aquatic Baseline Description.

5.3.2.4 Significance of Impacts (Pre-mitigation)

5.3.2.4.1 Construction Phase

5.3.2.4.1.1 **Impact of the Direct Loss of Estuarine Habitat and Biota**

The construction of the Project will involve the dredging of a strip of intertidal estuarine habitat of approximately 300 m length, which is primarily made up of mud/sandflats with small patches of mangrove. The removal of this habitat will result in the direct loss of estuarine habitat, as well as the impacts to fauna that use this area, such as waterbirds and fish. Intertidal organisms such as benthic macrofauna and mangroves are also likely to be lost. However, this area is already highly transformed, as satellite imagery indicates that the sandflat used to be populated with mangroves until relatively recently, but now has only a few small patches of mangrove.

Based on the analysis provided above, the impact of a direct loss of estuarine habitat and biota within the development footprint will be a "**Minor Negative Impact**" pre-mitigation (refer to Table 5-93).

Table 5-93: Rating of Impacts Related to the direct loss of estuarine habitat and biota within the development footprint (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Within the construction footprint
Duration	Permanent	The estuarine habitat will not recover and will be permanently removed.

Scale	300 m x ~250 m	The estuarine boundary and intertidal area of the project will be transformed.
Frequency	Once	Removal of estuarine habitat will be a once-off.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
Mangroves serve important ecosystem services such as sediment stabilisation, nutrient enrichment and habitat for other biota (see the “mangroves” section of the Estuarine Baseline Description) and as such, all mangrove habitat is valuable. There is little mangrove habitat left in the development site. That which does remain is considered particularly important		
Significance Rating Before Mitigation		
Minor Impact		

Impacts of Dredging on Estuarine Habitat and Biota

The impacts of dredging activities relate primarily to the physical removal of substratum and the associated fauna residing on or in it, and to a degree, the impact of resultant deposition of rejected material (Newell et al. 1998). In general, macrofaunal communities residing in fine sediments in estuaries are low in diversity and comprise species well adapted to rapid recolonisation on substratum that is frequently disturbed (Newell et al. 1998).

Dredging activities will result in short term increases in turbidity and total suspended solids (TSS), which may negatively impact various aspects of ecological function. Turbidity comprises both organic and inorganic particulates that are suspended in the water column (Van Ballegooyen et al. 2012), thus turbidity is ultimately a measure of light conditions in the water column. High levels of suspended solids have been shown to cause growth deficiencies in marine organisms and in some cases lead to mortalities due to smothering of benthic habitats. Benthic invertebrates are often more susceptible to the effects of turbidity, particularly those that filter-feed, as many lack the mobility inherent to fishes and therefore can ingest high levels of inorganic material filtered from the water resulting in lower growth rates or starvation and mortality. High TSS levels can also increase turbidity and decrease light penetration which can impact on primary production, respiration and feeding in marine species (such as plankton and small pelagic fish species).

Baseline surveys near the Project Site identified relatively low TSS levels in both the wet and dry seasons, with sites ranging between 4.9 – 13.8 mg/l in the wet season, and 1 – 17 mg/l during the dry season.

Fish are also affected by dredging, particularly those that are bottom dwellers like gobies and sole, while other larger species may simply be disturbed temporarily. Furthermore, elevated turbidity levels that are typically associated with dredging activities may also impact ichthyofauna communities. For example, piscivorous fishes in estuaries often rely on visual detection methods for capturing their prey, and increasing turbidity levels can impact negatively on this. Generally, piscivorous species found in estuaries are of marine origin, and can exit the estuary if turbidity levels become too high or too widespread. Turbidity generated by the dredging activities associated with the Project are anticipated to be localised, and most fish are expected to be able to move to more favourable areas of the estuary if these exceed their comfort levels.

Sessile organisms (benthic invertebrates), particularly those that filter-feed, are also susceptible to the effects of turbidity as many lack the mobility inherent to fishes. They can ingest high levels of inorganic material filtered from the water, resulting in lower growth rates, starvation and, in the worst cases, mortality. In addition, the higher the turbidity, the less the light can penetrate through the water column, which is likely to cause a temporary decrease in the productivity of autotrophic microphytobenthos and phytoplankton.

As dredging results in the resuspension of sediment, there is a concern that potentially toxic trace metals and hydrocarbons that have accumulated in the sediments in the Project area become resuspended within the water column. Trace metals are naturally occurring elements, some of which (e.g. copper & zinc) are required by organisms in considerable quantities (Phillips 1980). Aquatic organisms accumulate essential trace metals that occur naturally in water as a result of, for example, geological weathering. All of these metals, however, have the potential to be toxic to living organisms at elevated concentrations (Rainbow 1995) Human activities greatly increase the rates of mobilisation of trace metals from the earth's crusts and this can lead to increases in their bioavailability in coastal waters via natural runoff and pipeline discharges (Phillips, 1995). Metals occurring in sediments are generally inert (non-threatening) when buried in the sediment but can become toxic to the environment when they are converted to the more soluble form of metal sulphides. Metal sulphides are known to form as a result of natural re-suspension of the sediment (strong wave action resulting from storms) and from anthropogenic induced disturbance events like dredging.

The United States (US) National Oceanic and Atmospheric Administration (NOAA) has published a series of sediment screening values, which cover a broad spectrum of trace metal concentrations from toxic to non-toxic levels. The Effects Range Low (ERL) represents the concentration at which toxicity may begin to be observed in sensitive species. The ERL is calculated as the lower 10th percentile of sediment concentrations reported in literature that co-occur with any biological effect. (Buchman 2008). Comparing the sediment results from the estuarine survey to the NOAA guidelines may provide a useful indication of areas in the estuary where the sediments may be toxic to living organisms. However, this comparison does not provide an indication of whether the build-up of a trace metal is due directly to anthropogenic contamination of the environment, or whether it is an indirect result of other environmental influences, for example a high concentration of mud, as concentrations of metals in sediments are affected by grain size, Total Organic Content (TOC) and mineralogy. Comparisons with natural background levels from areas that are known to be unpolluted, or historical concentrations, are required to conclusively demonstrate anthropogenic enrichment. Another noteworthy caveat, the ERL guideline corresponds roughly to a 10% likelihood of toxicity, so this guideline represents a conservative (precautionary) approach (O'Connor 2004).

Baseline results indicate that heavy metal concentrations in sediment in the Project area are mostly low (<0.001 mg/kg) except for Iron (Fe), Zinc (Zn) and Cobalt (Co), which had average concentrations within the Project site of 3 605.0 mg/kg, 13.03 mg/kg and 2.76 mg/kg, respectively. The NOAA ERL for zinc in marine sediment is 150 mg/kg, well above the concentration found at the Project site (Buchman 2008).

Table 5-94. NOAA Effects Rangle Low (ERL) Marine Sediment Quality Guidelines Used to Assess Potential Toxicity From Elevated Trace Metal Levels.

Metal	NOAA ERL (mg/kg)
Arsenic (As)	8.2
Cadmium (Cd)	1.2
Chromium (Cr)	81
Copper (Cu)	34
Mercury (Hg)	0.15
Lead (Pb)	46.7
Nickel (Ni)	20.9
Zinc (Zn)	150

The extent of sediment resuspension during dredging operations is determined by a number of factors, such as the sediment type (mud/silt have smaller particle sizes and are therefore more readily resuspended than sands, proposed dredge type, as well as site conditions (such as water depth, current velocity, waves). Given that the Bonny River Estuary has the largest tidal volume of all of the Niger Delta rivers, and is the most affected by tidal movement, this impact may affect areas both up- and downstream of the dredge site, depending on the tidal state.

The proposed dredging will be to 13 m depth below chart datum. No modelling studies are available to quantify the extent of the area of dredge plume. A dredging method statement was provided pertaining to the proposed dredge activities. However, there is a lack of clarity on the volume of sediment to be dredged, and on the duration of this Project phase, and it was therefore challenging to define the exact extent of the area of impact. However, given the strong tidal influence within the Bonny River Estuary, it is considered likely that the dredge plume will conservatively extend across the estuary channel, and at least the same distance upstream and downstream (covering ~8 km^2 for the duration of the dredge operations).

Based on the analysis provided above, the impact from dredging on estuarine habitat and biota will be a "**Minor Negative Impact**" pre-mitigation (refer to *Table 5-95*).

Table 5-95: Rating of Impacts Related to dredging on the estuarine habitat and biota (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	While the spatial extent of the impact is generally restricted to the dredging area (with some exceedance beyond), piscivorous species would not be able to utilise this area during the dredge operations
Duration	Short term	Duration of dredging operations
Scale	~8 km^2	Given the strong tidal influence within the Bonny estuary, it is considered likely that the dredge plume will conservatively extend across the estuary channel, and at least the same distance upstream and downstream for the duration of the dredge operations.
Frequency	Ongoing during construction phase	After the initial excavation dredging may take place more than once a year. No maintenance plan is evident.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		
The most sensitive receptors are predatory fish, which are likely to be able to move out of the zone of impact during high turbidity events.		
Significance Rating Before Mitigation		
Minor Impact		

Impact of Construction Disturbance on Avifauna

The impact from disturbance from construction on avifauna will be a "**Moderate Negative Impact**" pre-mitigation (refer to Table 5-98). Of primary concern in this assessment are the potential impacts on the avifauna of the estuary, particularly wading birds, populations of which have declined dramatically on a global scale in recent. Construction phase impacts are related to general construction disturbance as well as dredging impacts pertinent to how avifauna use the system.

Noise pollution affects birds in a number of ways, including direct physical impacts (damage to hearing), stress, fright-flight, and avoidance responses. There are also potential behavioural impacts, including changes in foraging, reproductive success, communication and potential decreased response to audible alerts (from, for example, predators) (Ortega 2012). Physical damage to birds ears occurs from either very loud sounds of a short duration (>140dBA), from repeated loud noises (~125dBA), or from continuous (72h) exposure to noise of greater than 110dBA (Dooling and Popper 2007). A single sudden noise tends to have a larger impact than a continuous, more intense noise (Cutts et al. 2013).

However, “noise facilitation” can also occur, wherein a disproportionately large impact can occur if multiple relatively low intensity sounds occur at the same time, i.e., construction occurring concurrently with nearby motorboat activity. Construction noise typically falls within the second category (with repeated loud noise).

An example of various construction activities on an estuarine system, and the relative impacts on estuarine waterbirds is presented in Table 5-96, while the implications thereof are presented in Table 5-97. These data suggests that noise below 55dB emanating from a source outside of the mudflat and bank areas reduces potential for a response (and therefore, potentially negative impact) on birds in the immediate vicinity (Table 5-96). High and very high impacts (i.e., birds moving to areas which are less disturbed) result from the presence of personnel and plant equipment on mudflats (this should be restricted at all times), on the flood bank/flood plain and from occasional personnel on the crest of the bank, as well as irregular noise above 70dB (in this case, irregular piling) Table 5-96). Regular and irregular piling noise (of above 70dB and 50-700dB respectively) and long term presence of personnel on the crest of the bank will result in a moderate impact, while regular piling noise (50-70dB) will have a moderate to low impact (Table 5-96,Table 5-97).

A 70dB noise threshold is therefore set for the disturbance of waterbirds which, although being a coarse measure and not accounting for the influence of different forms of noise, gives an approximate indication of the noise levels that will cause harmful impacts to avifauna.

Table 5-96: Impacts of Construction Noise on Waterbirds in the Humber Estuary, United Kingdom (Cutts et al., 2013).

Type of Construction Noise	Impact of noise
Personnel and plant equipment on mudflats	High (and should be restricted at all times)
Third party on mudflats	High (but difficult to restrict)
Personnel and plant equipment on seaward toe and face	High to Moderate
Intermittent plant and personnel on crest	High to Moderate
Third party on bank	High to Moderate
Irregular piling noise (above 70dB)	High to Moderate
Long term plant and personnel crest	Moderate
Regular piling noise (above 70dB)	Moderate
Irregular piling noise (50dB – 70dB)	Moderate
Regular piling noise (50dB – 70dB)	Moderate to low
Occasional movement of crane	Moderate to low
Noise below 50dB	Low
Long term plant only on crest	Low
Activity behind flood bank (inland)	Low

Table 5-97: Resulting Noise Effects and the Response of Birds to Noise Impacts. Threshold Response Figures are for SPL at the Receptor (Cutts et al., 2013).

Noise impact	Description of resulting noise effect
High	Noise disturbance is typified by regular responses to stimuli with birds moving away from the works to areas which are less disturbed (within noise tolerances). Most birds

Noise impact	Description of resulting noise effect
	will show a degree of response to noise stimuli. Birds that remain in the affected area may not forage efficiently and if there are additional pressures on the birds (cold weather, extreme heat etc.) then this may impact upon the survival of individual birds or their ability to breed. For auditory disturbance to qualify as a high level, it must constitute a sudden noise event of over 60 dB (at the bird, not at source) or a more prolonged noise of over 72 dB.
Moderate	Moderate noise disturbance is typified as high-level noise which has occurred over long periods so that birds become habituated to it or lower-level noise which causes some disturbance to birds. This encompasses occasional noise events above 55 dB, regular noise 60-72 dB and long-term regular noise above 72 dB, where birds have become habituated. There is cross-over in moderate and high-level noise thresholds although the lower band can be assumed unless the species is particularly sensitive. Those species that are particularly sensitive are Brent Goose, Curlew & Redshank. Birds that may be more sensitive than average include Shelduck & Bar-tailed Godwit (Smit and Visser 1993)
Low	Low level noise is classed as that which is unlikely to cause response in birds using a fronting intertidal area. As such noises of less than 55dB at the bird are included in this category. These effects are likely to be masked by background inputs in all but the least disturbed areas and thus would not disturb the birds close by. Noise between 55-72dB in some highly disturbed areas e.g., industrial or urban areas and adjacent to roads, may feature a low level of disturbance provided the noise level was regular as birds will to often habituate to a constant noise level.

The noise levels generated by typical construction tools include pneumatic precision drills (~120dB at source), hammer drills (114dB), chain saws (110dB), spray painters (105dB), hand drills (98dB) and angle grinders (95-115dB) (Centre for Disease Control and Prevention (CDC) 2005). Given the scale of the construction phase of this Project, it is likely that noise levels will exceed 120dB at times when industrial machinery, such as jackhammers, are used (130dB). The dissipation of sound follows an inverse-square law, which means that for each doubling of distance from the noise source, the sounds pressure level will decrease by roughly 6dB. Source volumes of 130dB will dissipate below disturbance thresholds at approximately 675m from the source. Construction noise of this nature is likely to be intermittent, however, and it is more likely that typically construction noise will top out at approximately 120dB, meaning that noise levels for the proposed construction site will fall below disturbance levels of 70dB at approximately 300m from the source. Any birds present within these areas will likely experience noise disturbance (Dooling and Popper 2007, Ortega 2012).

It is unlikely that the construction noise levels will pose any risk of physical damage to local birds, unless they choose to remain in the area during loud construction. However, this is unlikely given that most birds will probably choose to evade/escape the noise and will move to another area of similar habitat (with intertidal mudflat habitat being abundant in the system). There is concern about construction noise during the nesting season of resident, ground-laying wader species, as the birds may abandon their clutch if disturbed by noise. However, given the existing site and vehicle traffic of the area, the local bird population is likely already well habituated to artificial noise which reduces the intensity of this impact. In addition to the impact on birds, construction noise and vibration in the channel may impact fish species, which may in turn results in changes in food available for piscivorous birds.

Most of the construction noise that occurs above the water surface is expected to have little impact on the underwater noise soundscape (Richardson et al. 1995), although drilling and pile driving are likely to have short term, high intensity impacts.

Table 5-98: Rating of Impacts Related to General Construction Disturbance to Avifauna (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Within construction footprint, and 300-675 m away from noise source.
Duration	Short term	Duration of construction activities
Scale	~300-675 m from site	Noise levels capable of disturbing birds are anticipated to attenuate to acceptable levels at this distance range.
Frequency	Ongoing	For the duration of the construction phase
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
Of primary concern in this assessment are potential impacts on the avifauna of the estuary, particularly wading birds, populations of which have declined significantly on a global scale in recent decades. The lack of information on the waterbird community present in the vicinity of the Project area reduces the confidence of this assessment, but following the Precautionary Principle, it is assumed that threatened bird species may be present.		
Significance Rating Before Mitigation		
Moderate Impact		

Impact of Dredging on Avifauna

Dredging operations may also cause disturbance to avian communities, and impact habitat use by these animals. Foraging and roosting avifauna are expected to avoid the sound source should it reach levels sufficient to cause discomfort. Dredging activities may also result in short term increases of turbidity and as such, dredging operations are expected to result in the temporary transformation of relatively clear open water habitat, to waters higher in turbidity. Elevated turbidity levels are known to restrict the foraging efficiency of visually hunting avian predators (Brenninkmeijer et al. 2002, Holbech et al. 2018).

Therefore, food availability for both piscivores and invertebrate feeders (as a result of elevated turbidity levels, as discussed above) may be affected by dredging operations, with negative impacts on avifaunal communities.

Based on the analysis provided above, the impact of dredging on avifauna is expected to be a "**Moderate Negative Impact**" pre-mitigation (refer to Table 5-99).

Table 5-99: Rating of Impacts Related to dredging disturbance to avifauna (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	While the spatial extent of the impact will be restricted to the dredging area (with some exceedance beyond), piscivorous species would not be able to utilise this area during the dredge operations
Duration	Short term	Duration of dredging operations
Scale	~8 km^2	Given the strong tidal influence within the Bonny estuary, it is considered likely that the dredge plume will conservatively extend across the estuary channel, and at least the same distance upstream and downstream for the duration of the dredge operations.
Frequency	Ongoing	No details are available regarding the dredge maintenance plan or duration.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
Of primary concern in this assessment are wading birds, populations of which have declined significantly on a global scale in recent decades. The lack of information on the waterbird community of the vicinity of the Project reduces the confidence of this assessment, but following the Precautionary Principle, assumes that threatened bird species may be present.		
Significance Rating Before Mitigation		
Moderate Impact		

Impact of Underwater Noise from Construction on Estuarine Biota

Depending on their distance from the Project development site, biota in the Bonny River Estuary could be impacted by underwater noise from construction activities. Anthropogenic noise in and around underwater habitats can impact the species inhabiting them. The extent and likelihood of underwater noise causing adverse impacts on aquatic life is dependent on the qualities of the sound such as the sound level, source frequency and duration of exposure, (Hastings & Popper 2005). Most research into the effects of underwater sound on aquatic life focuses on high level impulsive underwater noise such as blasting, seismic surveys, or impact piling, as these noises are more likely to have greater, more immediate and observable environmental effects. However, research into long-term, relatively low-level noise exposure, is increasing. Construction activities are likely to include both continuous noise sources such as drilling, and impulsive noise sources from activities such as piling.

Exposure to noise for a long period of time, such as is expected of the construction, can cause chronic effects, including developmental deficiencies and physiological stress (Popper and Hawkins 2016). These may affect life functions, including individual health and fitness, foraging efficiency, avoidance of predation, swimming energetics and reproductive behaviour (Popper and Hawkins 2016). However, as stated above, these responses to sound are dependent on the sound qualities and the sensitivity of different organisms to sound.

The most noise-sensitive groups in the Bonny River Estuary are expected to be aquatic mammals and fish. No aquatic mammals are confirmed to be present in the system, but species that may be found in the area include the African manatee (*Trichechus senegalensis* - IUCN VU) and Atlantic humpback dolphin (*Sousa teuszii* – IUCN CR) (IUCN 2022). Aquatic invertebrates are not anticipated to be impacted as they have been shown to be relatively insensitive to low frequency sound (Keevin and Hempen 1997). Fish are likely to be the noise-sensitive group most frequently present in the system. It is often assumed that fish will avoid disturbing noise, however, territoriality or a response of immobility may mean that the animal does not move away from the noise source (de Soto 2016).

Southall et al. (2019) presents cumulative weighted sound exposure criteria (SEL_{cum}) for mammals for non-impulsive noise sources, such as that of drilling, and impulsive noise sources, such as that of piling (Southall et al. 2019). SEL_{cum} are provided for both the onset of permanent threshold shift (PTS), where unrecoverable (but incremental) hearing damage may occur, and onset of temporary threshold shift (TTS), where a temporary reduction in hearing sensitivity may occur, in individual receptors. The Atlantic humpback dolphin is a ‘high-frequency cetacean’ with a generalised hearing range within 150 Hz to 160 kHz (Southall et al. 2019). For non-impulsive noise sources, high-frequency cetaceans have a TTS-onset threshold of 178 dB SEL_{cum} and a PTS-onset threshold of 198 dB SEL_{cum} (Southall et al. 2019). For impulsive noise sources, high-frequency cetaceans have TTS-onset threshold of 170 dB SEL_{cum} and a PTS-onset threshold of 185 dB SEL_{cum} (Southall et al. 2019). The sound produced by piling is dependent on the substrate and the hammer frequency, with sound levels of 178 dB re 1 $\mu Pa^2 s$ SEL and 164 dB re 1 $\mu Pa^2 s$ SEL at ranges of 57 m and 1,850 m respectively in one example, and 180 dB re 1 $\mu Pa^2 s$ SEL at 100 m, in another example (De Jong and Ainslie 2008). These data indicate that the Atlantic humpback dolphin would need to be within 100 m of the construction for 24 hours to experience the onset of TTS, which is considered unlikely.

Noise from piling has, however, been shown to cause behavioural changes in some cetacean species, such as movement out of the area of increased noise, at distances of up to 15km from the noise source (Thomsen et al. 2006, Brandt et al. 2018). This implies construction may cause Atlantic humpback dolphins to leave the area. Considering the Critically Endangered status of this species, any disturbance that may has energetic costs is of concern.

Fish use sound for communication, mating behaviour, detection of prey, avoidance of predators, orientation and migration, and habitat selection. Therefore, interference with or the masking of the ability of a fish to detect and respond to these sounds may decrease survival and fitness on an individual or population level (Popper and Hawkins 2019). Out of the more than 33 000 fish species that exist in the world, at least 800, from more than 100 families, are known to produce sounds (Bass and Ladich 2008, Popper and Hawkins 2019). Of the fish found in the waters of the Bonny River Estuary, sound-producing fish include those in the *Sciaenidae* and *Haemulidae* families. The Sciaenidae, also called drums or croakers, produce sound via the contraction of muscles around the swim bladders (Ramcharitar et al. 2001, Kasumyan 2008). One species of Sciaenid has been observed to produce enough noise that their choruses raised the ambient underwater sound levels by 50 dB (Ramcharitar et al. 2001). The common name of the Haemulidae, the grunters, references the sound they produce by grinding their teeth, which is amplified by their gas bladders (McEachran and Fechhelm 2006). Sciaenidae species in the system include Bobo croaker *Pseudotolithus elongatus* and Guinea croaker *Pseudotolithus epipercus*. Haemulidae species in the system include biglip grunt *Plectorhinchus macrolepis* and Sompat grunt *Pomadasys jubelini*. These groups produce sound primarily as part of their reproductive behaviour, calling to facilitate spawning aggregations, to attract mates and in competition between males (Ramcharitar et al. 2001).

Fish have been observed changing their chorusing for up to two days after being exposed to the sound from pile driving (Siddagangaiah et al. 2022). Even at relatively low received sound pressure levels of pile driving stimulus, fish have also been observed to exhibit behavioural changes such as increased swimming speed, freeze responses, and directional movement away from the sound source (Mueller-Blenkle et al. 2010). Like aquatic mammals, fish are expected to be able to detect the noise from pile driving up to tens of kilometres away from the noise source (Thomsen et al. 2006).

Authoritative guidelines for fish exposure to sound are provided in Popper et al. (2014), using categories for fish that are representative of a range of fish species, according to their anatomy. The most sensitive species of fish (those with a swim bladder involved in hearing) must be exposed to 186 dB SEL_{cum} (24-hour exposure) from piling to experience the onset of temporary threshold shift (TTS), where a temporary reduction in hearing sensitivity may occur in individual receptors (Table 5-100). This would require the fish to remain within less than 100 m of the piling noise source for 24 hours, depending on the noise level produced by the piling.

In cases of insufficient data availability to determine a robust numerical threshold, Popper et al. (2014) also provide qualitative criteria summarising the effect of noise on an individuals as having either a high, moderate or low risk in either the near-field (tens of metres), intermediate-field (hundreds of metres), or far-field (thousands of metres)

These qualitative criteria do not consider the noise level produced by the source.

Table 5-100. Criteria for mortality, recoverable injury and TTS in species of fish and turtles from noise from piling and summary of the qualitative effects on fish from noise from piling from Popper et al. (2014)[9].

[9] N = Near-field; I = Intermediate-field; F = Far-field). Distances are considered as follows: near-field (tens of metres), intermediate-field (hundreds of metres), or far-field (thousands of metres). Relative risk is ranked as high, moderate or low.

Type of animal	Mortality and potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Fish: no swim bladder	>219 dB SEL_{cum} or >213 dB peak	>216 dB SEL_{cum} or >213 dB peak	>>186 dB SEL_{cum}	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder is not involved in hearing	210 dB SEL_{cum} or >207 dB peak	203 dB SEL_{cum} or >207 dB peak	>186 dB SEL_{cum}	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder involved in hearing	207 dB SEL_{cum} or >207 dB peak	203 dB SEL_{cum} or >207 dB peak	186 dB SEL_{cum}	(N) High (I) High (F) Moderate	(N) High (I) High (F) Moderate
Sea turtles	210 dB SEL_{cum} or >207 dB peak	(N) High (I) Low (F) Low	(N) High (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) High (I) Moderate (F) Low
Eggs and larvae	>210 dB SEL_{cum} or >207 dB peak	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low

Notes: peak and rms sound pressure levels dB re 1 μPa; SEL dB re 1 $\mu Pa^2 \cdot s$. All criteria are presented as sound pressure even for fish without swim bladders since no data for particle motion exist. Relative risk (high, moderate, low) is given for animals at three distances from the source defi ned in relative terms as near (N), intermediate (I), and far (F).

As defined in Popper et al. (2014), masking is the “impairment of hearing sensitivity by greater than 6 dB, including all components of the auditory scene, in the presence of noise.” This is not a direct physiological effect on hearing but describes the effect of making a sound harder to hear due to the increase background noise. Behavioural effects are defined as “substantial change in behaviour for the animals exposed to a sound”. This may include long-term changes in behaviour and distribution, such as moving from preferred sites for feeding and reproduction, or alteration of migration patterns. This behavioural criterion does not include effects on single animals, or where animals become habituated to the stimulus, or small changes in behaviour such as a startle response or small movements” (Popper et al. 2014)

The above summary of qualitative effects on fish from piling noise indicates that fish that have a swim bladder that is not involved in hearing are at low risk of masking and moderate risk of behavioural changes at hundreds of metres of piling. Most Sciaenidae and Haemulidae present in the system are examples of such fish. However, some Sciaenidae do use their swim bladder in hearing and are therefore at moderate risk of masking even at thousands of metres from piling, meaning that it is possible that some fish in the system may have this high level of hearing sensitivity (Ramcharitar et al. 2001). As sound is intrinsic to the life history of these two fish families, it follows that they may be particularly vulnerable to the effects of masking.

There is limited information on the effects of anthropogenic underwater noise on invertebrates such as crustaceans (de Soto 2016). However, there is evidence that anthropogenic noise can cause marine invertebrates to experience masking of important biological sound cues, as well as sublethal physiological stress in response to high levels of sound such as that from vessel traffic or construction noise (Solan et al. 2016, Jézéquel et al. 2021, Hudson et al. 2022). Exposure to underwater broadband sound fields at 135–140 dB re 1 μPa can reduce the ability of sediment-dwelling invertebrates' (in this case, the decapod *Nephrops norvegicus*, and clam *Ruditapes philippinarum*) to undertake ecologically-important benthic nutrient cycling processes (Solan et al. 2016). Crustaceans have been shown to experience short- to medium-term stress or tissue repair effects in response to exposure to ship noise but may become adapted to such noise (Wale et al. 2013, Hudson et al. 2022). European lobsters (*Homarus gammarus*) were found to significantly increase their call rates in the presence of shipping noise of around 118.4 ± 7.7 SPL_{RMS} dB re 1 μPa, suggesting the need to vocally compensate for the reduction in intraspecific communication ability due to noise (Jézéquel et al. 2021). These are noise levels associated with drilling and piling, activities which may take place in the construction of the terminal, suggesting that crustaceans near to the construction activities may experience noise interference with ecologically important sounds.

In short, it is likely that construction will produce noise sufficient to cause fish and crustaceans nearby in the estuary to experience interference with biologically meaningful sound, which may have impacts on their distribution within the estuary during construction.

Given the differences in their sensitivity, marine mammals have been assessed separately to other estuarine biota.

Based on the analysis provided above, the impact from construction noise on estuarine biota (excluding marine mammals) constitute a "**Minor Negative Impact**" pre-mitigation (refer to Table 5-101*)*.

Table 5-101: Rating of Impacts Related to underwater construction noise on estuarine biota other than marine mammals (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Within hundreds of metres of the construction site
Duration	Short-term	For the duration of construction; particularly the piling period.
Scale	100s of metres	Estuarine biota may be impacted by construction sounds within hundreds of metres of the Project.
Frequency	Hourly	During construction of the quay, piling is likely to occur frequently during the day.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		

The most sensitive receptors are likely to be fish which utilise their swim bladder in hearing, or those for which sound is important for their life history, such as the Haemulidae and Sciaenidae, none of which that are known to be present in the estuary, are known to be threatened.
Significance Rating Before Mitigation
Minor Impact

Based on the analysis provided above, the impact from construction noise on estuarine mammals will be a "**Major Negative Impact**" pre-mitigation (refer to *Table 5-102*). Although the Atlantic humpback dolphin is a highly sensitive receptor, there is limited evidence that this species occurs in the Bonny River Estuary and as such there is low confidence in the below rating.

Table 5-102: Rating of Impacts Related to underwater construction noise on estuarine mammals (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Within kilometres of the construction
Duration	Short-term	For the duration of construction; particularly the piling period.
Scale	10km distance	Aquatic mammals may be disturbed by piling sounds from 10s of km away
Frequency	Hourly	During construction of the quay, piling is likely to occur frequently during the day.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
Atlantic humpback dolphins are Critically Endangered and highly noise sensitive. Following the Precautionary Principle, it is assumed that they are present in the Bonny River Estuary.		
Significance Rating Before Mitigation		
Major Impact		

Impact of Changes in Estuarine Form and Function

The dredging and construction along the estuarine boundary of the Project development area will result in changes to the form and function of the estuary. Construction will involve changing estuarine habitat, mainly consisting of intertidal mudflats and mangrove, to the hard, linear, vertical surface of the quay. The channel will be deepened alongside the quay. This will affect the hydrodynamics of the estuary, as hard surfaces have different reflective properties. However, given that a relatively small length of the estuary bank will be transformed, and the quay will be parallel to the general flow of water and an extension of the existing port, these changes to the hydrodynamics are not expected to have major impacts on the form and function of the estuary.

Based on the analysis provided above, the impact from changes in estuarine form and function will be a "**Minor Negative Impact**" pre-mitigation (refer to Table 5-103).

Table 5-103: Rating of Impacts Related to Changes in estuarine form and function (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The construction footprint
Duration	Permanent	The construction will create hard surfaces which will permanently alter the form of the estuary.
Scale	~300 m	The length of the quay
Frequency	Ongoing	This will be a continuously acting impact.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		
There are no significantly sensitive receptors to this impact.		
Significance Rating Before Mitigation		
Negligible Impact		

Impact of Changes in Stormwater Runoff due to Construction

As construction will be occurring alongside the estuary, there is a risk that loosened or disturbed soil and/or construction materials may be washed into the estuary. The resultant increased turbidity may negatively affect primary production, filter-feeding efficiency, the survival of suspension feeders and invertebrate larvae, the availability and suitability of food for higher order consumers, and an associated cascade of negative effects through the estuarine food web. However, estuarine faunal communities are generally tolerant of low visibility conditions, as these are often experienced due to nutrient-rich waters and turbid freshwater input. Furthermore, the Bonny River Estuary already experiences high levels of turbidity. Therefore, it is unlikely that sediment runoff from the development will significantly impact estuarine function due to increased turbidity. Level of contaminants in the stormwater runoff is also expected to be low given that this is a green field site.

Based on the analysis provided above, the impact from changes in stormwater runoff due to construction will be a "**Minor Negative Impact**" pre-mitigation (refer to Table 5-104).

Table 5-104: Rating of Impacts Related to changes in Stormwater Runoff due to Construction (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Project footprint
Duration	Short term	For the duration of the construction period
Scale	~300 m	Th estuarine boundary of the construction area
Frequency	Frequent	During the wet season rainfall is anticipated every day.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		
The most sensitive receptors are likely to be predatory fish, which are likely to be able to move out of the zone of impact during high runoff events.		
Significance Rating Before Mitigation		
Minor Impact		

5.3.2.4.2 Operational Phase

Impact of Artificial Light at Night on Estuarine Biota

Artificial light at night is a significant source of light pollution that interferes with the natural cycles of light and darkness and modifies the intensity, spectra, frequency and duration of light reaching and penetrating the natural water bodies, including the ocean's surfaces, and natural landscapes (Zapata et al. 2019, Commonwealth of Australia 2020, Nelson et al. 2021). During the operational phase, lighting at the terminal as well as any vessels transiting the estuary, are likely to be the greatest source of artificial light at night in the estuary.

The impact of artificial light at night on natural ecosystems and wildlife populations is receiving increasing research attention. There is now a wealth of information that illustrates that artificial light at night influences animal orientation, circadian rhythm (nocturnal and diel activity), spatial distribution, habitat use, migration/dispersal, foraging efficiency and predatory behaviour, schooling behaviour in fish, stress hormones, and reproduction and life history traits (Brüning et al. 2018, Nelson et al. 2021, Bassi et al. 2022). Artificial light at night can influence the different levels of ecosystem organisation from individual organisms' physiology and behaviour through to ecosystem function and provision of ecosystem services (Zapata et al. 2019).

The biological effects of artificial light at night include metabolic disruption, oxidative stress, immunological dysfunction, sleep loss, energy expenditure and altered growth rate (Navara and Nelson 2007, Bedrosian et al. 2011, Wyse et al. 2011, Gaston et al. 2015, Raap et al. 2015). These effects are linked to organisms' internal rhythms that are driven by daily, seasonal, and lunar light cycles (Gaston and Sánchez De Miguel 2017).

Sensitivity to light and requirements for optimal living conditions and ecological functioning varies between groups of organisms (e.g., invertebrates, fish, birds, reptiles, humans) and even within species (Commonwealth of Australia 2020). Most organisms utilise light or visual cues to locate and capture food. For aquatic species, it is well known that different taxa (such as phytoplankton, zooplankton, fish, squid and prawns) respond to artificial light (Timmer and Magellan 2011, Grubisic 2018, Bassi et al. 2022), and that biological responses vary with the magnitude, duration, frequency, and predictability of exposure to artificial light at night (Zapata et al. 2019).

Fish exhibit changes in circadian rhythm at illuminances (1 lux) that occur in indirectly illuminated environments (Brüning et al. 2018). Values well below 1 lux are commonly found for moonlight and skyglow (Jägerbrand and Bouroussis 2021). Normal working light from a ship has been found to disrupt fish and zooplankton behaviour to at least 200 m depth across an area of >0.125 km^2 around ships (Berge et al. 2020). It is important to note that behavioural responses to artificial light vary among taxa. While some species are known to be attracted to light, others are known to avoid light (Marangoni et al. 2022). Zooplankton tend to avoid light, undertaking diel vertical migration to depth during daylight to avoid the threat of visual predation, and surfacing at night to feed. Diurnal vertical migration is a characteristic feature in all oceans and is considered to be the largest synchronised movement of biomass on the planet (Hays 2003). This process has a strong effect on the movements of marine and estuarine communities and as it occurs in response to light, has the potential to be greatly affected by artificial light (Berge et al. 2020). Many nocturnal seabird species are highly attracted to artificial light, as they forage on bioluminescent prey (Montevecchi 2006). Marine birds have also been observed feeding in the artificial light from vessels, as the light tends to concentrate their prey (Montevecchi 2006, Marangoni et al. 2022). Overall, artificial light at night has the potential to create unnatural top–down regulation of fish and benthic invertebrate populations within urban estuarine and coastal waters, with implications for ecosystem structure and functioning (Becker et al. 2013, Bolton et al. 2017).

The amount of light spill that will reach the areas surrounding the Project site is unknown, but will be influenced to a large degree by climate/atmospheric conditions. Artificial skyglow (direct lighting emitted or reflected upwards, scattered in the atmosphere and reflected back to the ground; (Kyba et al. 2011) can spread light pollution up to hundreds of kilometres from its source (Luginbuhl et al. 2014). Lighting on vessels and at the terminal will contribute to artificial light at night and it is reasonable to assume from available literature, that there will be an impact on the estuarine ecology, particularly in the form of altered species assemblages, congregations, and foraging and predatory behaviour, and thus survival of species. However, given the extent to which the Onne Port is likely to already be illuminated at night, it is anticipated that the new terminal will not be a major contribution to large scale light pollution on the Bonny River Estuary.

Based on the analysis provided above, the impact from artificial light at night on estuarine biota will be a "**Moderate Negative Impact**" pre-mitigation (refer to Table 5-105).

Table 5-105: Rating of Impacts Related to artificial light at night on estuarine biota (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Illumination will have the greatest impact within hundreds of metres of the source.
Duration	Long term	Lighting will be used for the duration of the terminal's use.
Scale	>0.125 km^2 radius of light sources	Dependent on atmospheric conditions, the illumination capacity of lights, angle of lighting, etc.
Frequency	Nightly	Operations are expected to be illuminated throughout the night.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
The most sensitive receptors are likely to be roosting waterbirds near to the Project site, some of which are likely to be Endangered, Threatened or Protected Species, although information on this community is lacking.		
Significant Rating Before Mitigation		
Moderate Impact		

Impact of Increased Vessel Traffic on Estuarine Biota

Urea and ammonia will be exported from the new terminal by ship, meaning that the construction of the new terminal will result in an increase in vessel traffic in the Bonny River Estuary, which will have associated impacts on estuarine biota, such as that of increased underwater noise.

Anthropogenic noise in and around underwater habitats can impact species inhabiting these environments. The extent and likelihood of underwater noise causing adverse impacts on aquatic life is dependent on the qualities of the sound such as the sound level, source frequency and duration of exposure, (Hastings and Popper 2005). Most research into the effects of underwater sound on aquatic life focuses on high level underwater noise such as blasting, seismic surveys, or impact piling, as these noises are more likely to have greater, more immediate and observable environmental effects. However, research into long-term, relatively low-level noise exposure, such as that produced by motorised vessels, is increasing.

Exposure to continuous noise sources may cause chronic effects, including developmental deficiencies and physiological stress (Popper and Hawkins 2016). These may affect life functions, including individual health and fitness, foraging efficiency, avoidance of predation, swimming energetics and reproductive behaviour (Popper and Hawkins 2016). However, as stated above, these responses to sound are dependent on the sound qualities and the distance to the receptor.

The most noise-sensitive groups in the Bonny River Estuary are expected to be aquatic mammals and fish. No aquatic mammals are confirmed to be present in the system, but species that may be found in the area include the African manatee (*Trichechus senegalensis* – IUCN VU) and Atlantic humpback dolphin (*Sousa teuszii* – IUCN CR) (IUCN 2022). Aquatic invertebrates are not anticipated to be impacted as they have been shown to be relatively insensitive to low frequency sound (Keevin and Hempen 1997). Fish are likely to be the most noise-sensitive group most frequently present in the system. It is often assumed that animals will avoid disturbing noise. However, territoriality or a response of immobility may mean that the animal does not move away from the noise source (de Soto 2016).

Southall et al. (2019) presents cumulative weighted sound exposure criteria (SEL_{cum}) for mammals for non-impulsive noise sources, such as that of shipping (Southall et al. 2019). SEL_{cum} are provided for both the onset of permanent threshold shift (PTS), where unrecoverable (but incremental) hearing damage may occur, and onset of temporary threshold shift (TTS), where a temporary reduction in hearing sensitivity may occur in individual receptors. The Atlantic humpback dolphin is a 'high-frequency cetacean' with a generalised hearing range within 150 Hz to 160 kHz (Southall et al. 2019). High-frequency cetaceans have a TTS-onset threshold of 178 dB SEL_{cum} and a PTS-onset threshold of 198 dB SEL_{cum} (Southall et al. 2019).

Noise levels that are below the TTS-onset threshold may still negatively impact marine mammals through effects such as masking of biologically relevant sounds or causing behavioural changes, which may affect their ability to forage or avoid predation, for example. Bottlenose dolphins, which have the same generalised hearing range as the Atlantic humpback dolphin, were found to have a reduction in communication range of 26% when within 50 m of a small vessel traveling at 5 knots in shallow water, such as would be occurring within the Bonny River Estuary (Jensen et al. 2009). Boat traffic was also found to affect the acoustic behaviour of Pacific humpback dolphins in such a way as to suggest that the noise affected their group cohesion (Van Parijs and Corkeron 2001).

Manatees have better hearing capacity for high frequencies and relatively poor hearing sensitivity to the low frequencies typically associated with boat noise, making them a less vulnerable receptor to underwater noise pollution from vessel traffic (Gerstein 2002).

Fish use sound for communication, mating behaviour, detection of prey, avoidance of predators, orientation and migration, and habitat selection. Therefore, interference with, or the masking of, the ability of a fish to detect and respond to these sounds may decrease survival and fitness on an individual or population level (Popper and Hawkins 2019). Out of the more than 33 000 fish species worldwide, at least 800, from more than 100 families, are known to produce sounds (Bass and Ladich 2008, Popper and Hawkins 2019). Of the fish found in the waters of the Bonny River Estuary, sound-producing fish include those in the families Sciaenidae and Haemulidae. The Sciaenidae, also called drums or croakers, produce sound via the contraction of sonic muscles around the swim bladder (Ramcharitar et al. 2001, Kasumyan 2008). One species of Sciaenid has been observed to produce enough noise such that their choruses raised the ambient underwater sound levels by 50 dB (Ramcharitar et al. 2001). The common name of the Haemulidae, the grunters, references the sound they produce by grinding their teeth, which is amplified by their gas bladders (McEachran and Fechhelm 2006). Sciaenidae species in the system include Bobo croaker *Pseudotolithus elongatus* and Guinea croaker *Pseudotolithus epipercus*. Haemulidae species in the system include biglip grunt *Plectorhinchus macrolepis* and Sompat grunt *Pomadasys jubelini*. These groups primarily produce sound as part of their reproductive behaviour, calling to facilitate spawning aggregations, attract mates and in competition between males (Ramcharitar et al. 2001).

Authoritative guidelines for fish exposure to sound are provided in Popper et al. (2014), using categories for fish that are representative of general fish species, according to their anatomy. The most sensitive species of fish (those with a swim bladder involved in hearing) must be exposed to 158 dB SPL_{RMS} from continuous noise sources, such as shipping, for 12 hours to experience the onset of temporary threshold shift (TTS), where a temporary reduction in hearing sensitivity may occur in individual receptors (Table 5-106). In cases of insufficient data availability to determine a robust numerical threshold, Popper et al. (2014) also provide qualitative criteria summarising the effect of noise on an individual as having either a high, moderate or low risk in either the near-field (tens of metres), intermediate-field (hundreds of metres), or far-field (thousands of metres) (Table 5-106). These qualitative criteria do not consider the noise level produced by the source.

Table 5-106. Criteria for recoverable injury and TTS in species of fish from continuous noise sources and summary of the qualitative effects on fish from continuous noise from Popper et al. (2014) (N = Near-field; I = Intermediate-field; F = Far-field). Distances are considered as follows: near-field (tens of metres), intermediate-field (hundreds of metres), or far-field (thousands of metres). Relative risk is ranked as high, moderate, or low.

Type of animal	Mortality and potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Fish: no swim bladder	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder is not involved in hearing	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder involved in hearing	(N) Low (I) Low (F) Low	170 dB SPL_{RMS} for 48 hrs	158 dB SPL_{RMS} for 12 hrs	(N) High (I) High (F) High	(N) High (I) Moderate (F) Low
Eggs and larvae	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) Moderate (I) Moderate (F) Low

As defined in Popper et al. (2014), masking is the “impairment of hearing sensitivity by greater than 6 dB, including all components of the auditory scene, in the presence of noise.” This is not a direct physiological effect on hearing but describes the effect of making a sound harder to hear due to the increase background noise. Behavioural effects are defined as “substantial change in behaviour for the animals exposed to a sound”. This may include long-term changes in behaviour and distribution, such as moving from preferred sites for feeding and reproduction, or alteration of migration patterns. This behavioural criterion does not include effects on single animals, or where animals become habituated to the stimulus, or small changes in behaviour such as a startle response or small movements” (Popper et al. 2014)

The above summary of qualitative effects on fish from continuous noise sources indicates that fish that have a swim bladder that is not involved in hearing are likely to be at high risk of masking and moderate risk of behavioural changes at hundreds of metres from a continuous noise source, such as a motorised vessel. The Sciaenidae and Haemulidae present in the system are examples of such fish. However, some Sciaenidae do use their swim bladder in hearing and are therefore at high risk of masking even at thousands of metres from a continuous noise source, meaning that it is possible that some fish in the system may have this high level of hearing sensitivity (Ramcharitar et al. 2001). As sound is intrinsic to the life history of these two fish families, it follows that they may be particularly vulnerable to the effects of masking. Sciaenids are most sensitive to low-frequency sounds, such as those produced by motorised vessels, so they are likely to experience masking of the frequencies most important to their reproductive behaviour (Horodysky et al. 2008). Furthermore, ship noise has been found to have negative effects on the growth and immunophysiology of some Sciaenid species (Lin et al. 2019).

Other important receptors in the area include the various waterbird species. Most information on the noise sensitivity of semi-aquatic birds focuses on impulsive noise sources such as seismic surveys, and there is little research on their sensitivity to continuous low-level underwater noise. Diving birds use underwater noise in foraging and associated communication (Hansen et al. 2017, McInnes et al. 2020). In particular, white-breasted cormorants *Phalacrocorax carbo,* were found to have an underwater hearing threshold comparable with hearing experts such as odontocetes, with a threshold of 71 dB re 1 µPa RMS at 2 kHz (Hansen et al. 2017). Research on the impacts of impulsive noise sources found that gentoo penguins *Pygoscelis papua* showed strong avoidance responses to bursts of broadband noise of between 115 and 120 dB re 1 µPa RMS, while another diving bird, the common murre *Uria aalge*, showed avoidance responses to noise levels as low as 110 re 1 µPa RMS (Anderson Hansen et al. 2020, Sørensen et al. 2020). Pichegru et al. (2022) noted that an increase in shipping noise in Algoa Bay, South Africa was accompanied by an 85% decline in the numbers of a nearby African penguin colony. Other non-diving waterbirds are also sensitive to ship noise, with research indicating that vessels should maintain a buffer distance of at least 200 m from waterbirds to reduce disturbance such as interference in their foraging and flight behaviour (Rodgers and Schwikert 2002, Wang et al. 2022). More research into the sensitivity of diving birds to underwater noise is clearly needed, but these results do suggest that diving birds may have potential responses to the noise from a large vessel on par with high-frequency cetaceans. Thus, although broadband burst noise has different qualities to that of ship noise, it is likely that diving birds will also react to ship noise (Anderson Hansen et al. 2020).

The extent to which the increase in vessel traffic due to the Project is likely to affect the estuarine biota in the Bonny River Estuary is also dependent on the existing underwater noise levels in the estuary, to which additional vessel traffic will contribute, and the amount of additional vessel traffic. Given the capacity of Onne Port, it is expected that noise sensitive organisms in the system may be somewhat adapted to high underwater noise levels from large vessels, or alternatively experience high levels of masking and/or physiological stress due to this noise.

Given the differences in their sensitivity, estuarine mammals have been assessed separately to other estuarine biota.

Based on the analysis provided above, the impact from increased vessel traffic, including the impact of underwater noise on estuarine biota (excluding marine mammals) will be a "**Moderate Negative Impact**" pre-mitigation (refer to Table 5-107). As little information is available on the waterbirds present on the Bonny River Estuary, the confidence in the assessment of the impact of underwater noise on waterbirds is low.

Table 5-107: Rating of Impacts Related to Underwater Noise on Estuarine Biota other than Mammals (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Noise impacts will extend hundreds of metres from the source
Duration	Long-term	The duration of the operation of the terminal
Scale	Estuary-wide	Vessels travelling along the estuary will produce noise
Frequency	Bi-weekly	It is assumed that a total 30 vessels for Urea and 6 vessels for Ammonia will be operating in a year.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
The most sensitive receptors are likely to be fish which utilise their swim bladder in hearing, or those for which sound is important for their life history, such as the Haemulidae and Sciaenidae, and diving waterbirds. The lack of information on the waterbird community in the vicinity of the Project reduces the confidence of this assessment, but following the Precautionary Principle, it is assumed that threatened, noise-sensitive bird species may be present.		
Significant Rating Before Mitigation		
Moderate Impact		

Based on the analysis provided above, the impact from increased vessel traffic, including the impact of underwater noise on estuarine mammals will be a "**Medium Negative Impact**" pre-mitigation (refer to

Table 5-108). Although the Atlantic humpback dolphin is a highly sensitive receptor, there is limited evidence that this species occurs in the Bonny River Estuary and as such there is low confidence in the below rating.

Table 5-108: Rating of Impacts Related to Underwater Noise on Estuarine Biota Other than Mammals (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Noise impacts will extend hundreds of metres from the source
Duration	Long-term	The duration of the operation of the terminal
Scale	Estuary-wide	Vessels travelling along the estuary will produce noise
Frequency	Bi-Weekly	It is assumed that a total 30 vessels for Urea and 6 vessels for Ammonia will be operating in a year
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
The most sensitive receptors are likely to be the IUCN Critically Endangered Atlantic Humpback Dolphin, which is a highly noise-sensitive species.		
Significant Rating Before Mitigation		
Medium Impact		

Impact of Routine Discharges from Vessels

Ships carrying ballast water have been recorded since the late nineteenth century. By the 1950s, the older practice of carrying dry ballast had been almost completely phased out. Ballast is essential for the efficient handling and stability of ships during ocean crossings and when entering a port. Ballast water is either freshwater or seawater taken up at ports of departure and discharged on arrival where it is pumped aboard, the volume being held being dependant on the cargo load. The conversion to ballast water caused a major wave of marine invasions worldwide, as species with a larval or planktonic phase in their life cycle were now able to be transported long distances between ports on board ships. Furthermore, because ballast water is usually loaded in shallow and often turbid port areas, sediment is also loaded along with the water and this can support a host of infaunal species (Hewitt et al. 2009). The global nature of the shipping industry makes it inevitable that many ships must load ballast water in one area and discharge it in another, which has an increasing potential to transport non-indigenous species to new areas. It has been estimated that major cargo vessels annually transport nearly 10 billion tonnes of ballast water worldwide, indicating the global dimension of the problem (Gollasch et al. 2002).

It is estimated that on average, 3,000 to 4,000 species are transported between continents by ships each day (Carlton and Geller 1993). Once released, these non-indigenous species have the potential to establish in a new environment which is potentially free of predators, parasites and diseases, and thereby outcompete and impact on native species and ecosystem function, fishing and aquaculture industries, as well as public health (Gollasch et al. 2002). Invasive species include planktonic dinoflagellates and copepods, nektonic Scyphozoa, Ctenophora, Mysidacea, benthos such as annelid oligochaeta and polychaeta, crustaceans, brachyura ,molluscan bivalves, and fish (Carlton & Geller 1993). Carlton & Geller (1993) record 45 'invasions' attributable to ballast water discharges in various coastal states around the world. In view of the recorded negative effects of alien species transfers, the International Maritime Organisation (IMO) considers the introduction of harmful aquatic organisms and pathogens to new environments via ships ballast water as one of the four greatest threats to the world's oceans (Awad et al. 2003).

Ballast water can, and often does, include high levels of contaminants such as trace metals and hydrocarbons, and, along with the vessels that carry the ballast water, likely serves to transport alien species from other parts of the world into the Bonny River Estuary. Ballast water discharges can, however, be effectively managed and the remit of the IMO is to reduce the risks posed by ballast water to a minimum through the direct treatment of the water while on board the ship, as well as by regulating the way in which ballast water is managed while the ship is at sea. Furthermore, due to the variability of salinity in estuaries, marine alien species are less likely to be able to establish themselves in the Bonny River Estuary.

Ships also routinely discharge sewage. Sewage is harmful to biota due to its high concentrations of nutrients which stimulate primary production that in turn can lead to changes in species composition, decreased biodiversity, increased dominance, and toxicity effects.

As the Project will involve changes in the cargo load a ship is carrying, it will be associated with loading and unloading of ballast water. Increased vessel traffic in the Bonny River Estuary due to the Project may be associated with increased ballast water discharge and sewage discharge.

Based on the analysis provided above, the impact from routine discharges from vessels will be a "**Minor Negative Impact"** pre-mitigation (refer to Table 5-109).

Table 5-109: Rating of Impacts Related to Routine Discharges from Vessels (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Impacts will extend for a few hundred metres from the source.
Duration	Long-term	For the duration of the project

Scale	~100 m radius or greater	Dependent on volume and qualities of ballast or sewage.
Frequency	Daily	Ballast and sewage are regularly discharged by cargo vessels.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		
There are no substantially sensitive receptors to this impact		
Significant Rating Before Mitigation		
Minor Impact		

5.3.2.5 *Residual Impact (Post-mitigation)*

5.3.2.5.1 *Construction Phase*

Residual Impacts Related to Direct Loss of Estuarine Habitat and Biota

Based on the implementation of the proposed mitigation measures, the significance of the impact to direct loss of estuarine habitat and biota within the development footprint will be a "**Negligible Negative Impact**" post mitigation (refer to Table 5-110).

Table 5-110: Rating of Residual Impacts Related to the direct loss of estuarine habitat and biota within the development footprint (Post-Mitigation).

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Within the construction footprint
Duration	Permanent	The estuarine habitat will be permanently removed.
Scale	300 m x ~250 m	The estuarine boundary and intertidal area of the project will be transformed.
Frequency	Once	Removal of estuarine habitat will be a once-off.
Magnitude		
Negligible Magnitude		
Significant Rating After Mitigation		
Negligible Impact		

Residual Impacts of Dredging on Estuarine Habitat and Biota

Based on the implementation of the proposed mitigation measures, the significance of the impact of dredging on estuarine habitat and biota will be a "**Negligible Negative Impact**" post mitigation (refer to Table 5-111).

Table 5-111: Rating of Residual Impacts of Dredging on Estuarine Habitat and Biota (Post-Mitigation)

Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	While the spatial extent of the impact is generally restricted to the dredging area (with some exceedance beyond), piscivorous species would not be able to utilise this area during the dredge operations
Duration	Short term	Duration of dredging operations
Scale	~8 km^2	Given the strong tidal influence within the Bonny estuary, it is considered likely that the dredge plume will conservatively extend across the estuary channel, and at least the same distance upstream and downstream for the duration of the dredge operations.
Frequency	Ongoing	Maintenance dredging will be required. No details are available regarding the dredge maintenance plan or duration.
Magnitude		
Small Magnitude		
Significant Rating After Mitigation		
Negligible Impact		

Residual Impacts of Disturbance from Construction to Avifauna

Based on the implementation of the proposed mitigation measures, the significance of the impact to disturbance from construction to avifauna will be a "**Minor Negative Impact**" post mitigation (refer to Table 5-112).

Table 5-112: Rating of Residual Impacts Related to disturbance from construction to avifauna (Post-Mitigation).

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Within construction footprint, and 300-675 m away from noise source.
Duration	Short term	Duration of construction activities
Scale	~300-675 m from site	Noise levels capable of disturbing birds are anticipated to attenuate to acceptable levels at this distance range.
Frequency	Ongoing	For the duration of the construction phase

Magnitude
Small Magnitude
Significant Rating After Mitigation
Minor Impact

Residual Impacts of Dredging on Avifauna.

Based on the implementation of the proposed mitigation measures, the significance of the impact of dredging on avifauna will be a "**Minor Negative Impact**" post mitigation (refer to Table 5-113).

Table 5-113: Rating of Residual Impacts of Dredging on Avifauna (Post-Mitigation).

Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	While the spatial extent of the impact is generally restricted to the dredging area (with some exceedance beyond), piscivorous species would not be able to utilise this area during the dredge operations
Duration	Short term	Duration of dredging operations
Scale	~8 km2	Given the strong tidal influence within the Bonny estuary, it is considered likely that the dredge plume will conservatively extend across the estuary channel, and at least the same distance upstream and downstream for the duration of the dredge operations.
Frequency	Ongoing	Maintenance dredging will be required. No details are available regarding the dredge maintenance plan or duration.
Magnitude		
Small Magnitude		
Significant Rating After Mitigation		
Minor Impact		

Residual Impacts Related to Underwater Construction Noise on Estuarine Biota

Based on the implementation of the proposed mitigation measures, the significance of the impact of underwater construction noise on estuarine biota other than marine mammals will be a "**Minor Negative Impact**" post mitigation (refer to Table 5-114).

Table 5-114: Rating of Residual Impacts Related to underwater construction noise on estuarine biota other than marine mammals (Post-Mitigation).

Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Within hundreds of metres of the construction site
Duration	Short-term	For the duration of construction; particularly the piling period.

Scale	100s of metres	Estuarine biota may be impacted by construction sounds within hundreds of metres of the Project.
Frequency	Hourly	During construction of the quay, piling is likely to occur frequently during the day.
Magnitude		
Small Magnitude		
Significant Rating After Mitigation		
Minor Impact		

Residual Impacts Related to Underwater Construction Noise on Estuarine Mammals.

Based on the implementation of the proposed mitigation measures, the significance of the impact of underwater construction noise on estuarine mammals will be a "**Moderate Negative Impact**" post mitigation (refer to Table 5-115).

Table 5-115: Rating of Residual Impacts Related to Underwater Construction Noise on Estuarine Mammals (Post-Mitigation).

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Within kilometres of the construction
Duration	Short-term	For the duration of construction; particularly the piling period.
Scale	10 km distance	Aquatic mammals may be disturbed by piling sounds from 10s of km away
Frequency	Hourly	During construction of the quay, piling is likely to occur frequently during the day.
Magnitude		
Small Magnitude		
Significant Rating After Mitigation		
Moderate Impact		

Residual Impacts Related to Changes in Estuarine form and Function

Based on the implementation of the proposed mitigation measures, the significance of the impact to changes in estuarine form and function will be a "**Minor Negative Impact**" post mitigation (refer to Table 5-116).

Table 5-116: Rating of Residual Impacts Related to changes in estuarine form and function (Post-Mitigation).

Rating of Impacts

Characteristic	Designation	Summary of Reasoning
Extent	Local	The construction footprint
Duration	Permanent	The construction will create hard surfaces which will permanently alter the form of the estuary.
Scale	~300 m	The length of the quay
Frequency	Ongoing	This will be a continuously acting impact.
Magnitude		
Small Magnitude		
Significant Rating After Mitigation		
Minor Impact		

5.3.2.5.1.1 **Residual Impacts Related to Changes in Stormwater Runoff due to Construction**

Based on the implementation of the proposed mitigation measures, the significance of the impact to changes in stormwater runoff due to construction will be a "**Minor Negative Impact**" post mitigation (refer to Table 5-117).

Table 5-117: Rating of Residual Impacts Related to changes stormwater runoff due to construction (Post-Mitigation).

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Project footprint
Duration	Short term	For the duration of the construction period
Scale	~300 m	Th estuarine boundary of the construction area
Frequency	Frequent	During the wet season rainfall is anticipated every day.
Magnitude		
Small Magnitude		
Significant Rating After Mitigation		
Minor Impact		

5.3.2.5.2 *Operational Phase*

Residual Impact of Artificial Light at Night on Estuarine Biota

Based on the implementation of the proposed mitigation measures, the significance of the impact to light on estuarine biota will be a "**Minor Negative Impact**" post mitigation (refer to Table 5-118).

Table 5-118: Rating of Residual Impacts Related to light on estuarine biota (Post-Mitigation).

Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Illumination will have the greatest impact within hundreds of metres of the source.
Duration	Long term	Lighting will be used for the duration of the terminal's use.
Scale	>0.125 km^2 radius of light sources	Dependent on atmospheric conditions, the illumination capacity of lights, angle of lighting, etc.
Frequency	Nightly	Operations are expected to be illuminated throughout the night.
Magnitude		
Small Magnitude		
Significant Rating After Mitigation		
Minor Impact		

Residual Impact of Underwater Noise Related to Increased Vessel Traffic on Estuarine Biota

Based on the implementation of the proposed mitigation measures, the significance of the impact of underwater noise on estuarine biota will be a "**Minor Negative Impact**" post mitigation (refer to Table 5-119).

Table 5-119: Rating of Residual Impacts Related to underwater noise from operations on estuarine biota (Post-Mitigation).

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Noise impacts will extend hundreds of metres from the source
Duration	Long-term	The duration of the operation of the terminal
Scale	Estuary-wide	Vessels travelling along the estuary will produce noise
Frequency	Bi-weekly	It is assumed that a total 30 vessels for Urea and 6 vessels for Ammonia will be operating in a year.
Magnitude		
Small Magnitude		
Significant Rating After Mitigation		
Minor Impact		

Residual Impacts Related to Increased Vessel Traffic on Estuarine Mammals

Based on the implementation of the proposed mitigation measures, the significance of the impact of underwater noise from operations on estuarine mammals will be a "**Moderate Negative Impact**" post mitigation (refer to Table 5-120).

Table 5-120: Rating of Residual Impacts Related to Underwater Noise on Estuarine Biota Other than Mammals (Post-Mitigation).

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Within kilometres of the construction
Duration	Short-term	For the duration of construction; particularly the piling period.
Scale	10 km distance	Aquatic mammals may be disturbed by piling sounds from 10s of km away
Frequency	Hourly	During construction of the quay, piling is likely to occur frequently during the day.
Magnitude		
Small Magnitude		
Significant Rating After Mitigation		
Moderate Impact		

Residual Impact of Routine Discharges from Vessels

Based on the implementation of the proposed mitigation measures, the significance of the impact of routine discharges from vessels will be a "**Moderate Negative Impact**" post mitigation (refer to Table 5-121).

Table 5-121: Rating of Residual Impacts Related to Routine Discharges from Vessels (Post-Mitigation).

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Impacts will extend for a few metres from the source.
Duration	Long-term	For the duration of the project
Scale	~100 m radius or greater	Dependent on volume and qualities of ballast or sewage.
Frequency	Daily	Ballast and sewage are regularly discharged by cargo vessels.
Magnitude		
Small Magnitude		
Significant Rating After Mitigation		
Moderate Impact		

5.3.2.6 *Impacts from Unplanned Events*

Impact of Fuel Spills and Other Pollution

Water quality in the vicinity of ships may be impaired by various forms of waste discharged into the marine environment. Objects which are particularly detrimental to aquatic fauna include plastic bags and bottles, pieces of rope and small plastic particles. All reasonable measures must be implemented to ensure that no littering takes place during construction and operation. Large numbers of aquatic organisms are killed or injured daily by becoming entangled in debris or as a result of the ingestion of small plastic particles (Gregory 2009, Wright et al. 2013). If allowed to enter the ocean, this solid waste may be transported by currents for long distances out to sea and around the coast. Thus, unlike fuel or sewage contamination, the extent of the damage caused by solid waste is potentially large. The unmitigated impact of floating or submerged solid materials on aquatic life (especially birds and fish) can be lethal and can affect rare and endangered species.

During the construction period, there is the potential for accidental spills of hydrocarbons, oils from construction vehicles and other equipment, and other harmful substances and chemicals used (e.g., concrete). This may enter the water column directly during construction activities or be transported as contaminated runoff into the estuary from land-based activities as a result of incorrect handling and improper spill management.

Vessel operators may experience accidental spills from operational machinery, which could include hydrocarbons such as hydraulic fluids, diesel, oils and/or hazardous substances. Spills of this nature are highly toxic and unless carefully managed, may pollute estuarine and coastal environments as well as damage and potentially destroy marine and estuarine organisms (Moore & Dwyer 1974).

Based on the analysis provided above, the impact from fuel spills and other pollution will be a "**Major Negative Impact**" pre-mitigation (refer to Table 5-122).

Table 5-122: Rating of Impacts Related to Fuel Spills and other Pollution (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Regional	Depending on how rapidly a spill is contained, fuel spills can affect a large area.
Duration	Days, months or years	Dependent on success of cleaning operations, fuel and plastic spills can persist in the environment for years to decades.
Scale	~10 km	Given the strong tidal influence of the Bonny River Estuary, it is likely that spilled oil will be transported far from the source.
Frequency	Once or more in project lifetime	Referring to fuel spills, other pollution such as plastic litter is likely to be very frequent.

Likelihood	Low	The event is likely to occur at some time during normal operating conditions; likely to occur once or more in life of the project
Magnitude		
Major Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
Following the Precautionary Principle, the most sensitive receptors are threatened species such as the Atlantic humpback dolphin, and species which serve important ecosystem functions such as mangroves, both of which would be highly affected by fuel spills. This impact would affect a wide range of estuarine biota, including fisheries species, so although individual receptors may not be specifically sensitive, as a whole the ecosystem impacted is rated as highly sensitive.		
Significant Rating Before Mitigation		
Major Impact		

5.3.2.6.1.1 **Impact of Spills of Ammonia-derived Products**

Although unlikely, spills of ammonia or urea may occur during the transfer of these substances from storage onto vessels. Liquid ammonia is highly toxic and highly soluble in water and may cause acute lethal effects to organisms that come into contact with it. However, it does not persist in the environment so chronic toxicity is not anticipated. Hydrolysed ammonia tends to form a cloud which can travel through the air at ground level to affect a large area, in the order of kilometres, as it interacts with the land and water beneath it. The extent of damage of such a spill would be dependent on the quantity spilled, its location in relation to the estuary (and water with which it can react), and the rate at which the ammonia cloud rises (Fritt-Rasmussen et al. 2022).

Ammonia spills can also cause nitrification of estuarine environments, in which excess amounts of NO_3^- can result in eutrophication as well as toxicity for estuarine organisms (Fritt-Rasmussen et al. 2022).

While urea is not toxic to aquatic organisms, urea spills may also cause nutrification of estuarine systems and may result in algal blooms (some of which may be toxic), which can have negative knock-on effects for estuarine organisms (Finlay et al. 2010, Olesen et al. 2020).

Based on the analysis provided above, the impact from spills of ammonia-derived products will be a "**Major Negative Impact**" pre-mitigation (refer to *Table 5-123).*

Table 5-123: Rating of Impacts Related to spills of Ammonia-Derived Products (Pre-Mitigation)

Type of Impact		
Direct Negative Impact (Ammonia spill)		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Regional	The cloud formed from an ammonia spill may travel kilometres before dispersing.

Duration	Medium-term	Consequences may have medium-term effects on the life history traits of aquatic organisms
Scale	~ 1 -10 km from source	Dependent on size of spill
Frequency	Almost never	Under normal operating conditions this should not occur.
Likelihood	Unlikely	The event is unlikely but may occur at some time during normal operating conditions; known of in the industry
Magnitude		
Major Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
An impact of this kind would affect a wide range of organisms, including those important for ecosystem services such as fisheries. Although the most sensitive species are unlikely to be present, the estuary as a whole is highly sensitive to this impact.		
Significant Rating Before Mitigation		
Major Impact		

Impact of Catastrophic Loss of Containment

Ammonia poses a risk of explosion. As ammonium nitrate explodes, it produces massive amounts of pollutant gases, including nitrogen dioxide, nitrous oxide and ammonia, which are toxic to aquatic organisms. Depending on the size of explosion, sediment, waste, fuel and building materials may be transported into the estuary, which will have pollutant effects. Explosions may also lead to fire, which can threaten the mangrove forests growing near the development site.

Based on the analysis provided above, the impact from catastrophic loss of ammonia containment will be a "**Major Negative Impact**" pre-mitigation (refer to Table 5-124).

Table 5-124: Rating of Impacts Related to catastrophic loss of containment (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Regional	Will affect a greater area than the area of development.
Duration	Medium-term	Consequences are not limited to the duration of the loss of containment, and may have longer term effects on the life history traits of aquatic organisms
Scale	~1 to 10 km	Dependent on quantity of ammonia stored.
Frequency	Extremely infrequent	Given the safety protocols in place, this should not occur.
Likelihood	Unlikely	The event is unlikely but may occur at some time during normal operating conditions; known of in the industry

Magnitude
Major Magnitude
Sensitivity/Vulnerability/Importance of the Resource/Receptor
High Sensitivity
An impact of this kind would affect a wide range of organisms, including those important for ecosystem services such as fisheries. Although the most sensitive species are unlikely to be present, the estuary as a whole is highly sensitive to this impact.
Significant Rating Before Mitigation
Major Impact

5.3.2.7 *Residual Impact (Post Mitigation) From Unplanned Events*

Residual Impact of Fuel Spills and Other Pollution

Based on the implementation of the proposed mitigation measures, the significance of the impact of fuel spills and other pollution will be a "**Moderate Negative Impact**" post mitigation (refer to Table 5-125).

Table 5-125: Rating of Residual Impacts Related to Fuel Spills and other Pollution (Post-Mitigation).

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	A rapidly contained spill may only affect a small area.
Duration	Days, months or years	Dependent on success of cleaning operations, fuel and plastic spills can persist in the environment for many years to decades.
Scale	100s of metres	Well-contained fuel spills should not be transported more than a few 100 m.
Frequency	Almost never	If mitigation measures are followed, pollution should not occur.
Likelihood	Unlikely	The event is unlikely but may occur at some time during normal operating conditions; known of in the industry
Magnitude		
Major Magnitude		
Significant Rating After Mitigation		
Moderate Impact		

Residual Impact of Spills of Ammonia-derived Products

Based on the implementation of the proposed mitigation measures, the significance of the impact of spills of ammonia-derived products will be a "**Moderate Negative Impact**" post mitigation (refer to Table 5-126).

Table 5-126: Rating of Residual Impacts Related to spills of ammonia-derived products (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	The cloud formed from an ammonia spill may travel kilometres before dispersing.
Duration	Medium-term	Consequences may have medium-term effects on the life history traits of aquatic organisms
Scale	~ 1 -10 km from source	Dependent on size of spill – should be smaller following mitigation measures.
Frequency	Almost never	Under normal operating conditions this should not occur.
Likelihood	Unlikely	The event is unlikely but may occur at some time during normal operating conditions; known of in the industry
Magnitude		
Major Magnitude		
Significant Rating After Mitigation		
Moderate Impact		

Residual Impact of Catastrophic Loss of Containment

Based on the implementation of the proposed mitigation measures, the significance of the impact of catastrophic loss of containment will be a "**Moderate Negative Impact**" post mitigation (refer to Table 5-127).

Table 5-127: Rating of Residual Impacts Related to Catastrophic loss of Containment (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Mitigation measures reduce the likelihood of a large loss of containment
Duration	Medium-term	Consequences are not limited to the duration of the loss of containment, and may have longer term effects on the life history traits of aquatic organisms
Scale	~1 to 10 km	Dependent on quantity of ammonia stored.
Frequency	Extremely infrequent	Given the safety protocols in place, this should not occur.
Likelihood	Unlikely	The event is unlikely but may occur at some time during normal operating conditions; known of in the industry
Magnitude		
Major Magnitude		
Significant Rating After Mitigation		
Moderate Impact		

5.4 Impacts on Socio-Economic Environment from Planned Activities

This Section assesses the predicted socio-economic, cultural heritage, traffic, and transportation impacts (both positive and negative) associated with the Project. The predicted risks and impacts to the socio-economic environment:

- Economy and Employment Impacts (*Section* 5.4.1)
- Community Health and Safety Impacts (*Section 5.4.2*)
- Community Stability and Livelihood Impacts (*Section* 5.4.3)
- Labour and Working Conditions Impacts (*Section* 5.4.4)
    - Impacts on Socio-Economic Environment from Unplanned Activities (*Section 5.4.5*)
    - Traffic Impacts (*Section 5.4.6*)
- Cultural Heritage Impacts (Section 5.4.7)
- Consideration of Hazard and Operability Risk (Section 5.4.8)

5.4.1 Economy and Employment Impact Assessment

5.4.1.1 Description of the Baseline Environment

Nigeria is Sub-Saharan Africa's largest economy, with oil comprising the main source of government revenue. Economic growth since 2008 has been largely driven by the agricultural, telecommunications, and service sectors, with oil production steadily declining since 2012.

Despite economic growth and diversification, 62% of Nigeria's population live in extreme poverty. Employment for the majority of the population (70%) is in agriculture. Livelihoods are centred around primary activities (agriculture and fishing), and local trade.

5.4.1.2 Proposed Project Activities

The development of a large infrastructure projects like the MM FZE Port Project typically brings with it several positive impacts in terms of local economic stimulation, as well as the creation of job opportunities locally, regionally, and nationally (refer to Table 5-128).

Table 5-128: Potential Positive Impacts on Economy and Employment.

Construction Phase	Operation Phase
• Temporary direct and indirect employment opportunities. • Temporary economic impacts from taxes and fees, procurement, and worker spending. • Long-term benefits from capacity enhancement of local labour.	• Direct and indirect employment opportunities. • Long-term economic benefits from taxes and fees, procurement, and worker spending.

More specifically, the Project will:

- Employ a projected peak workforce of 643 during the construction phase, with a projected 40% of jobs sourced locally (Eleme and Ogu-Bolo), 55% nationally (within Nigeria), and 5% internationally.
- During the operational phase, the anticipated workforce is 220, of which 210 jobs will be sourced nationally and 10 internationally.
- Throughout both construction and operational phases, generate local, regional, and national tax revenue. Furthermore, it will source various materials and services for construction and operation, some of which may feasibly be sourced from within local communities and contribute to local socio-economic development.
- Commit to making diploma engineer and graduate engineer internships available, although it is at this stage MM FZE are unclear how many internships will be available and during what lifecycle phase, they will be made available.

5.4.1.3 Sensitive Receptors

There are communities within the AoI, namely Onne in Eleme Local Government Area and Ogu in Ogu-Bolo Local Government Area. The regional and national areas are also likely to be positively impacted by economic opportunities.

5.4.1.4 Significance of Impacts

Based on the analysis provided above, the impact on the local economy and employment opportunities will be a "**Moderate Positive Impact"** "impact (refer to Table 5-129). As this is a positive impact, no mitigation is required.

Table 5-129: Rating of Impacts Related to Economy and Employment.

Project Phase		
Construction and Operation		
Type of Impact		
Positive		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The highest impact is likely to occur within the project-affected communities and broader Eleme and Ogu-Bolo areas. National and international impacts, while likely to occur are going to have a negligible impact.
Duration	Long-term	The highest positive impacts on the local economy and employment opportunities will occur during the construction phase, however, positive impacts will last throughout operational phase and to the end of the asset's life.
Scale	Medium	The peak construction workforce and operational workforce projections are reasonably high. Furthermore, positive impacts are enhanced through the creation of indirect employment and stimulation of local businesses within

		the host communities, as well as the ongoing generation of local, regional, and national tax revenue.
Frequency	Continuous	Opportunities may differ according to the type of work being performed (e.g. construction vs operational activities), but the impact is considered continuous.
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
There is low formal employment within the project-affected communities; therefore, it is anticipated that economic opportunities may have a moderate impact on these communities (especially given the commitment to source 40% of construction jobs from local communities). Given the reliance on informal economic activities and agriculture, it is anticipated that any spend locally (even temporary) may have a moderate impact on these communities (depending on level of local spend, sourcing of materials and services).		
Impact Rating		
Positive Impact		

5.4.2 Community Health and Safety Impact Assessment

5.4.2.1 Description of the Baseline Environment

There are several healthcare facilities in Onne and Ogu such as hospitals, private medical clinics, birthing clinics/facilities, and health care centres. As with the national Nigerian context, it is assumed that the public healthcare sector is under-equipped to service the population within the AoI.

According to the baseline data collection, the most common forms of ill health in the communities are malaria and typhoid fever. Other prevalent ailments are upper respiratory tract infections, skin diseases, measles, dysentery, and diarrhoea. Non-communicable diseases like hypertension and diabetes have increased in the communities over time.

It is assumed that, as with the national Nigerian context, infrastructure challenges exist in terms of insufficient electricity generation and transmission capacity, low levels of piped water and sanitation coverage, and deteriorating road networks as a result of lack of maintenance10.

As per the human rights baseline, public security forces in Nigeria have been documented as utilising excessive force when dealing with the public, especially in light of several active conflicts in the country.

5.4.2.2 Proposed Project Activities

The development of the Project within an existing industrialised area, with access routes through densely populated community areas, and requiring securing of the site by private and public security forces, results in a number of potential negative impacts on community health and safety if not appropriately managed (Table 5-130).

Table 5-130: Potential Impacts on Community Health and Safety.

Construction Phase	Operation Phase

[10] Foster, V. and Pushak, N. 2013. *Nigeria's Infrastructure: A Continental Perspective.* Policy Research Working Papers, World Bank Group.

• Increase road safety risk. • Increased transmission of communicable diseases. • Increased exposure to environmental health risks. • Increased risk of crime and conflict. • Reduced access to healthcare facilities. • Increased exposure to security personnel.	• Increased risk of exposure to environmental health risks; and • Long-term exposure to security personnel

More specifically for the Project:

- The main access route to the construction site will use existing roads traveling through Onne, as well as the existing industrial area within the broader port complex. Remote sensing, as well as inputs gathered during stakeholder engagements, indicate the presence of a large market in Onne alongside the major access road.
- During operational phase, the transport of urea and ammonia products for export by truck will utilise the main access road through Onne town as well as the existing industrial area within the port zone.
- It is currently estimated that 386 non-local workers will be brought into the area during construction phase. The Local Hiring Plan refers to accommodation facilities for expatriate manpower, but not for non-local manpower sourced from elsewhere within Nigeria. It is therefore assumed that the approximately 354 workers sourced nationally will either live within traveling distance of the Project site or be expected to find accommodation within the Onne and Ogu communities. The interaction between a large contractor workforce and local communities may result in instances of transactional sex, spread of communicable diseases like HIV/AIDS, and potentially gender-based harm.
- All major infrastructure development projects include environmental health impacts associated with noise, dust, and vibrations.
- Given that the proposed Project site is currently vacant and presumably unsecured, it will be necessary to secure (including potential fencing) the site. Furthermore, it is assumed that private security service providers will be contracted to protect the site from potential encroachment or criminal activity.
- In addition to the presence of contracted private security providers, the Nigerian police force or military may also support the proponent in securing the Project site or addressing any potential conflict or unrest in surrounding community areas.

5.4.2.3 Sensitive Receptors

The close proximity of settlements, other social services, and the Onne market all suggest that pedestrians regularly walk alongside and also cross the main access route to the Project site. Increased traffic due to the transportation of workers, construction equipment, as well as construction vehicles all pose a risk to pedestrians and other road users in terms of road safety.

Given its proximity to the site and access routes, the town of Onne will likely experience the most negative health and safety impacts from the presence of the Project workforce, as well as security and human rights related risks.

The areas immediately adjacent to the proposed site are existing industrial areas, with the community of Owo Ogono being 1.4km away across a channel of water, Onne being 5,7km away by land, and Ogu being 8km by land. Therefore, while dust, noise, and vibrations will be present, these should have a limited impact as no human settlement is directly adjacent to the proposed Project site.

5.4.2.4 Significance Impacts.

5.4.2.4.1 Road Safety Risks Pre-Mitigation

Based on the analysis provided above, the impact related to road safety risks will be a "**Major Negative Impact"** pre-mitigation (refer to **Error! Reference source not found.)**

Table 5-131: Rating of Impacts Related to Road Safety Risks Pre-Mitigation.

Type of Impact		
Direct Negative		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
EXTENT	Regional	Construction-related traffic, as well as export trucks handling urea and ammonia, will likely travel from the broader Port Harcourt area to the Project site, however, the impact and road safety risk will be most significant within the town of Onne.
Duration	Long-term	The presence of additional traffic, resulting in road safety risks, will occur throughout construction and throughout the operational life of the asset.
Scale	Medium	102 additional vehicles will travel along local routes during peak construction, and 214 additional vehicles during operational phase.
Frequency	Continuous	During construction and operational phases, vehicular traffic to and from the site will occur daily.
Magnitude		
Medium		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High		
Local road users, including market traders, pedestrians, and local vehicular traffic, are sensitive to potential road safety impacts. Groups such as school children, pregnant women, and people with disabilities are particularly vulnerable to road safety incidents.		
Significant Rating Before Mitigation		
Major		

Road Safety Risks Post-Mitigation

Based on the analysis provided above, the impact related to road safety risks will be "**Moderate Negative Impact**" post-mitigation (refer *to* Table 5-132**)**

Table 5-132: Rating of Impacts Related to Road Safety Risks Post-Mitigation.

Type of Impact		
Direct Negative		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Communities directly surrounding the site will still experience the greatest impacts, but these can be successfully mitigated to a lower impact level.
Duration	Short-term	Given the construction phases is anticipated to last 18 months, the impact is considered short-term.
Scale	Small	While non-local workers cannot be avoided due to low levels of local skills, appropriate mitigations such as planning for healthcare needs of non-local workers can reduce the scale of the impact.
Frequency	Continuous	During construction phase, non-local contractor workers will be present within local communities daily. Furthermore, dust, noise, and vibration impacts will occur daily during construction phase.
Magnitude		
Small		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High		
Local road users, including market traders, pedestrians, and local vehicular traffic, are sensitive to potential road safety impacts. Groups such as school children, pregnant women, and people with disabilities are particularly vulnerable to road safety incidents.		
Significant Rating Post-Mitigation		
Moderate		

Communicable Diseases, Environmental Health and Reduced Access to Healthcare Facilities Pre-Mitigation

Based on the analysis provided above, the impact related to communicable diseases, environmental health, and access to healthcare facilities will be a "**Moderate Negative Impact"** pre-mitigation (refer *to Table 5-133*).

Table 5-133: Rating of Impacts Related to Communicable Diseases, Environmental Health, and Reduced Access to Healthcare Facilities Pre-Mitigation.

Type of Impact		
Direct Negative		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning

Extent	Local	Communities where contractor workers reside (most likely in Onne and Ogu) will be most impacted. The village of Owo Ogono will experience the greatest environmental health impacts.
Duration	Short-term	Given the construction phases is anticipated to last 18 months, the impact is considered short-term.
Scale	Medium	As per the local hiring plan, 386 non-local workers are anticipated to be present in the area during peak construction phase. The nearest community is at least 1,4km from the site, as such dust, vibration, and noise impacts are anticipated to be minimal.
Frequency	Continuous	During construction phase, non-local contractor workers will be present within local communities daily. Furthermore, dust, noise, and vibration impacts will occur daily during construction phase.
Magnitude		
Medium		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium		
Given the urban and industrialised nature of the AoI, the Project will increase health and safety impacts somewhat above the baseline situation. The settlement of Owo Ogono will be most sensitive to environmental health impacts. Women in the AoI are particularly vulnerable to sexual exploitation and gender-based harm.		
Significant Rating Pre-Mitigation		
Moderate		

Communicable Diseases, Environmental Health and Reduced Access to Healthcare Facilities Post-Mitigation

Based on the analysis provided above, the impact related to communicable diseases, environmental health, and access to healthcare facilities will be "**Minor Negative Impact**" post-mitigation (refer to Table 5-134).

Table 5-134: Rating of Impacts Related to Communicable Diseases, Environmental Health, and Reduced Access to Healthcare Facilities.

Type of Impact		
Direct Negative		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Communities directly surrounding the site will still experience the greatest impacts, but these can be successfully mitigated to a lower impact level.
Duration	Short-term	Given the construction phases is anticipated to last 18 months, the impact is considered short-term.
Scale	Small	While non-local workers cannot be avoided due to low levels of local skills, appropriate mitigations such as planning for healthcare needs of non-local workers can reduce the scale of the impact.

Frequency	Continuous	During construction phase, non-local contractor workers will be present within local communities daily. Furthermore, dust, noise, and vibration impacts will occur daily during construction phase.
Magnitude		
Small		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium		
Given the urban and industrialised nature of the AoI, the Project will increase health and safety impacts somewhat above the baseline situation. The settlement of Owo Ogono will be most sensitive to environmental health impacts. Women in the AoI are particularly vulnerable to sexual exploitation and gender-based harm.		
Post-Mitigation (Residual)		
Minor		

5.4.2.4.2 Crime, Conflict, Security and Human Rights Pre-Mitigation

Based on the analysis provided above, the impact related to crime, conflict, security, and human rights will be a "**Moderate Negative Impact**" pre-mitigation (refer to Table 5-135).

Table 5-135: Rating of Impacts Related to Crime, Conflict, Security, and Human Rights Pre-Mitigation.

Type of Impact		
Direct Negative		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The impact of private security service providers and the presence of public security forces will be limited to the area immediately surrounding the Project site, the town of Onne, and to a lesser extent the town of Ogu.
Duration	Long-term	It is anticipated that a combination of private and public security will be active at the site throughout its operational life.
Scale	Small	The relative distance of the site from local communities suggests that interactions with security will be minimal. However, impacts may also extend along the access routes to the site, should protection for construction equipment or vehicles be required.
Frequency	Continuous	As security will be likely be required on an ongoing basis, the frequency is considered to be continuous.
Magnitude		
Medium		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium		
Potential vulnerability to human rights impacts or conflict as a result of the presence of private security can be high, dependent on the due diligence processes applied when appointing service providers. However, physical		

separation between the Project site and nearest local communities suggests that interactions between private security providers and community members will be minimal. The potential involvement of public security along access routes to the Project site suggests impacts could be experienced within the centre of Onne town. The relative lack of control of the Proponent of public security activities introduces an element of uncertainty which somewhat increases community vulnerability to this impact, resulting in an overall sensitivity of medium
Pre-Mitigation
Moderate

Crime, Conflict, Security and Human Rights Post-Mitigation

Based on the analysis provided above, the impact related to crime, conflict, security, and human rights will be a "**Minor Negative Impact**" post-mitigation (refer to *Table* 5-136*)*.

Table 5-136: Rating of Impacts Related to Crime, Conflict, Security, and Human Rights Post-Mitigation.

Type of Impact		
Direct Negative		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	The impact of private security service providers and the presence of public security forces will be limited to the area immediately surrounding the Project site, the town of Onne, and to a lesser extent the town of Ogu.
Duration	Long-term	It is anticipated that a combination of private and public security will be active at the site throughout its operational life.
Scale	Negligible	Appropriate application of international frameworks such as the Voluntary Principles on Security and Human Rights can significantly reduce the scale of the impact should security forces/service providers come into contact with local communities/
Frequency	Continuous	As security will be likely be required on an ongoing basis, the frequency is considered to be continuous.
Magnitude		
Small		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium		
Potential vulnerability to human rights impacts or conflict as a result of the presence of private security can be high, dependent on the due diligence processes applied when appointing service providers. However, physical separation between the Project site and nearest local communities suggests that interactions between private security providers and community members will be minimal. The potential involvement of public security along access routes to the Project site suggests impacts could be experienced within the centre of Onne town. The relative lack of control of the Proponent of public security activities introduces an element of uncertainty which somewhat increases community vulnerability to this impact, resulting in an overall sensitivity of medium		
Post-Mitigation (Residual)		
Minor		

5.4.3 Community Stability and Livelihoods Impact Assessment

5.4.3.1 Description of the Baseline Environment

An analysis of satellite information between 2002 and 2022 reveals densification and expansion of the human settlements of Onne and Ogu-Bolo. This suggests the presence of influx into these communities, likely consisting of jobseekers, migrant workers, or those seeking to benefit socio-economically from the Port Zone due to close living proximity.

Respondents within the AoI are 78,94% reliant on agriculture related livelihoods, while only 21,06% rely on non-agriculture related livelihoods. Furthermore, 48,76% of respondents rely on livelihood activities directly related to fishing or the processing of fish. As such, any potential Project impacts on natural resources (and particularly fishing resources) may have significant impacts on community livelihoods.

It is assumed that, as with the national Nigerian context, infrastructure challenges exist in terms of insufficient electricity generation and transmission capacity, low levels of piped water and sanitation coverage, and deteriorating road networks as a result of lack of maintenance11.

The proponent has implemented a number of corporate social responsibility (CSR) projects between 2016 and 2023 within the communities of Onne and Ogu-Bolo.

5.4.3.2 Proposed Project Activities

The Project will employ a projected peak workforce of 643 during the construction phase, with an anticipated workforce of 220 during operational phase.

It is assumed that the proponents CSR initiatives will continue and potentially expand given the development of new infrastructure, however, the specifics of these plans are not currently detailed.

The presence of a large workforce during construction, as well as associated influx due to job seekers, camp followers, and induced economic activity, can both alter existing stability within local communities, and place additional pressure on social resources and public services such as accommodation, schools, livelihoods, and natural resources (Table 5-137). Furthemore, given the high reliance on subsistence fishing within the AoI, the physical footprint of the Project may potentially impact community fishing livelihoods.

Table 5-137: Potential Impacts on Community Stability and Livelihoods.

Construction Phase	Operation Phase
• Disturbance from the presence of workforce. • Disruption to local subsistence livelihoods – specifically fishing. • Increased pressure on social resources and public services (e.g. accommodation, schools,	• Unmet expectations of benefits. • Disruption to local subsistence livelihoods – specifically fishing. • Presence of expats or non-local staff within communities.

[11] Foster, V. and Pushak, N. 2013. *Nigeria's Infrastructure: A Continental Perspective.* Policy Research Working Papers, World Bank Group.

competition for livelihood and natural resources). • Unmet expectations of benefits.	

5.4.3.3 Sensitive Receptors

Nearby towns of Onne (within the Eleme LGA) and Ogu (within the Ogu-Bolo LGA) will likely experience the greatest impacts related to in-migration of a workforce and potential influx. Furthermore, social resources and public services in these areas will experience the greatest pressure. Communities using the waterway directly adjacent to the Project site will be sensitive to disruptions to fishing livelihood activities.

5.4.3.4 Significance of Impacts

Presence of a Workforce and Pressures on Social Resources Pre-Mitigation

Based on the analysis provided above, the impact due to the presence of a workforce and pressures on social resources will be a "**Moderate Negative Impact**" impact pre-mitigation (refer to Table 5-138).

Table 5-138: Rating of Impacts Related to the Presence of a Workforce and Pressures on Social Resources Pre-Mitigation.

Type of Impact		
Direct, indirect, and induced negative impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Regional	While the Project workforce and potential jobseekers may settle near to the Project site, influx is likely to occur more broadly throughout Onne and Ogu-Bolo, especially when considering formal and informal economic activity created during construction and operational phases. Pressure on social resources will be felt most acutely in Onne and Ogu towns.
Duration	Long-term	Migrants are likely to settle fairly permanently and throughout the construction and operation phases of the Project.
Scale	Medium	IFC guidelines suggest that for every formal Project job created, between three and ten additional jobs are created in the project area. Furthermore, an estimated three to four "camp followers" per formal job may be attracted during construction and operational phases[12].
Frequency	Continuous	Frequency of influx is likely to occur sporadically throughout the year, with notable differences measured on an annual basis.
Magnitude		
Medium		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		

[12] Projects and People: A Handbook for Addressing Project-Induced In-Migration (ifc.org)

Medium
The Project is likely to cause influx, especially during the construction period, and further due to induced migration. However, influx is likely to be cumulative in nature across various large industries in the AoI. Baseline indications suggest that social resources are already under pressure in the AoI, hence the Project may exacerbate this.
Pre-Mitigation
Moderate

Presence of a Workforce and Pressures on Social Resources Post-Mitigation

Based on the analysis provided above, the impact due to the presence of a workforce and pressures on social resources will be a "**Minor Negative Impact**" post-mitigation (refer to Table 5-139).

Table 5-139: Rating of Impacts Related to the Presence of a Workforce and Pressures on Social Resources Post-Mitigation.

Type of Impact		
Direct, indirect, and induced negative impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Regional	While the Project workforce and potential jobseekers may settle near to the Project site, influx is likely to occur more broadly throughout Onne and Ogu-Bolo, especially when considering formal and informal economic activity created during construction and operational phases. Pressure on social resources will be felt most acutely in Onne and Ogu towns.
Duration	Short-term	Where skills and services can be effectively developed within local communities, the reliance on externally sourced labour and procurement may mostly be limited to the construction phase.
Scale	Medium	IFC guidelines suggest that for every formal Project job created, between three and ten additional jobs are created in the project area. Furthermore, an estimated three to four "camp followers" per formal job may be attracted during construction and operational phases.
Frequency	Continuous	Frequency of influx is likely to occur sporadically throughout the year, with notable differences measured on an annual basis.
Magnitude		
Small		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium		
The Project is likely to cause influx, especially during the construction period, and further due to induced migration. However, influx is likely to be cumulative in nature across various large industries in the AoI. Baseline indications suggest that social resources are already under pressure in the AoI, hence the Project may exacerbate this.		
Post-Mitigation (Residual)		
Minor		

Disruption of Local Subsistence Livelihoods Pre-Mitigation.

Based on the analysis provided above, the impact related to the disruption of local subsistence livelihoods will be a "**Minor – Negative Impact**" pre-mitigation (refer to Table 5-140).

Table 5-140: Rating of Impacts Related to the Disruption of Local Subsistence Livelihoods Pre-Mitigation.

Type of Impact		
Direct negative impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	It is likely that only communities who use waters within the direct vicinity of the Project will be impacted.
Duration	Permanent	The impact related to site establishment, construction, and operation is considered to be permanent.
Scale	Medium	The impact on fishing livelihoods could be medium scale for households. While fishing may be one of the key local livelihoods, there are a number of other areas that can be accessed.
Frequency	Continuous	Access to fishing waters will be disrupted on a daily/ongoing basis.
Magnitude		
Medium		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low		
While surrounding communities reliant on fishing livelihoods are likely economically vulnerable, the prevalence of waterways in the area suggests that relocation to other areas to continue fishing will be possible.		
Pre-Mitigation		
Minor		

Disruption of Local Subsistence Livelihoods Post-Mitigation.

Based on the analysis provided above, the impact related to the disruption of local subsistence livelihoods will be a "**Negligible Negative Impact**" post-mitigation (refer to *Table 5-141).*

Table 5-141: Rating of Impacts Related to the Disruption of Local Subsistence Livelihoods Post-Mitigation.

Type of Impact		
Direct negative impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning

Extent	Local	It is likely that only communities who use waters within the direct vicinity of the Project will be impacted.
Duration	Permanent	The impact related to site establishment, construction, and operation is considered to be permanent.
Scale	Small	Ongoing and transparent communication with impacted stakeholders may support affected communities to adapt to the impact. Furthermore, should the pre-mitigation impact be larger than anticipated, support through livelihood restoration programmes should be provided.
Frequency	Continuous	Access to fishing waters will be disrupted on a daily/ongoing basis.
Magnitude		
Small		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low		
While surrounding communities reliant on fishing livelihoods are likely economically vulnerable, the prevalence of waterways in the area suggests that relocation to other areas to continue fishing will be possible.		
Post-Mitigation (Residual)		
Negligible		

Unmet Expectations of Benefits-Pre-Mitigation

Based on the analysis provided above, the impact related to unmet community expectations of benefits will be a "**Moderate Negative Impact**" pre-mitigation (refer to Table 5-142).

Table 5-142: Rating of Impacts Related to Unmet Expectations of Benefits Pre-Mitigation.

Type of Impact		
Direct negative impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Communities within Onne and Ogu, typically considered the host communities of the Port Zone, will likely have the highest expectation for socio-economic benefit from the Project.
Duration	Medium-term	Expectations are likely to peak during construction phase, with a reduction in expectation levels during operations. Expectation levels are directly linked to the risk of community anger.
Scale	Medium	Previous corporate social responsibility investments within host communities suggest that expectations will likely increase with the expansion of the proponent's footprint in the local area.
Frequency	Continuous	Community expectations, perceptions, and anger may fluctuate or emerge daily.
Magnitude		

Medium
Sensitivity/Vulnerability/Importance of the Resource/Receptor
Medium
The socioeconomic conditions of the AoI suggest high levels of poverty and desperation for socioeconomic opportunity. Given the proximity of the host communities to the Project's major access route, community anger may potentially result in work stoppages or truck blockades due to community disruptions arising from unmet expectations.
Pre-Mitigation
Moderate

Unmet Expectations of Benefits Post-Mitigation

Based on the analysis provided above, the impact related to unmet community expectations of benefits will be a "**Minor Negative Impact**" post-mitigation (refer to Table 5-143).

Table 5-143: Rating of Impacts Related to Unmet Expectations of Benefits Post-Mitigation.

Type of Impact		
Direct negative impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Communities within Onne and Ogu, typically considered the host communities of the Port Zone, will likely have the highest expectation for socio-economic benefit from the Project.
Duration	Short-term	While it is unavoidable for the Project to create some community expectations, proactive expectation management can ensure realistic community expectations from the beginning of construction phase, and minimise risks related to community anger.
Scale	To be determined using stakeholder management procedures	Upon commencement of construction and implementation of mitigation measures, the Incident and Grievance Register and Commitment Register will measure the scale of community expectations.
Frequency	Quarterly	If channelled correctly, all community expectations and grievances can be addressed during standing community meetings.
Magnitude		
Small		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium		
The socioeconomic conditions of the AoI suggest high levels of poverty and desperation for socioeconomic opportunity. Given the proximity of the host communities to the Project's major access route, community anger may potentially result in work stoppages or truck blockades due to community disruptions arising from unmet expectations.		

Post-Mitigation (Residual)
Minor

5.4.4 Labour and Working Conditions Impact Assessment

5.4.4.1 Description of the Baseline Environment

As per the human rights baseline, a number of significant human rights challenges face Nigeria. Nigeria has a relatively comprehensive set of laws protecting worker rights, however, implementation and enforcement within the public and private sectors is low[13]. Weak state institutional capacity for enforcement and the vulnerability of workers in an unstable economic environment may create conditions in which worker's rights are not adequately respected.

5.4.4.2 Proposed Project Activities

Generally speaking, human rights impacts may be related to the potential for poor labour and working conditions, including inadequate worker health and safety processes and procedures (Table 5-144). Furthermore, unfair recruitment practices may result in the exclusion of vulnerable groups, or potential corruption related to the distribution of employment opportunities.

Table 5-144: Potential Impacts on Labour and Working Conditions.

Construction Phase	Operation Phase
• Labour and working conditions / workers' rights, including worker health and safety; and • Unfair Recruitment practices	• Labour and working conditions / workers' rights, including worker health and safety

However, the above being said, the Project has a local hiring plan in place for construction and operational phases. The plan includes policies for non-discrimination, encouragement of women to take up work, a child labour prohibition policy, protection for the principles of collective bargaining and freedom of association, as well as a human rights policy.

Furthermore, the Project has an employee grievance management procedure in place to ensure that employees have an appropriate mechanism for lodging of grievances, that these grievances are adequately investigated, and that appropriate appeal procedures are in place.

5.4.4.3 Sensitive Receptors

All permanent and temporary workers, both employed directly by MM FZE and indirectly by contractors. Unskilled labourers from impoverished areas are particularly vulnerable to this impact.

[13] Adewumi, F. & Adenugba, A. (2010). *The state of workers' rights in Nigeria: an examination of the banking, oil and gas and telecommunication sectors.* Friedrich-Ebert-Stiftung. Available at: [The state of workers' rights in Nigeria (fes.de)]

5.4.4.4 Significance of Impacts Pre-Mitigation.

Based on the analysis provided above, the impact of labour, working conditions, and unfair recruitment practices will be a "**Moderate Negative Impact**" pre-mitigation (refer to **Table 5-145**).

Table 5-145: Rating of Impacts Related to Labour, Working Conditions, and Unfair Recruitment Practices Pre-Mitigation.

Type of Impact		
Direct negative impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Regional	While a large proportion of the workforce will be sourced locally, especially during construction phase, workers will also be sourced regionally and nationally.
Duration	Long-term	Potential impacts related to labour, working conditions, and recruitment practices are anticipated to last throughout the operational life of the asset.
Scale	Medium	The impact is considered medium in scale as the Project will be a significant employer within the local economy.
Frequency	Continuous	During all phases of the Project lifecycle, a workforce will be required for the Project, albeit at fluctuating levels across construction and operation.
Magnitude		
Medium		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium		
High levels of poverty within the AoI suggest that unskilled labourers are vulnerable to potentially unfair recruitment practices and poor working conditions. The human rights context in Nigeria does not ensure governmental oversight regarding appropriate and safe labour policies and working conditions which respect human rights, placing the onus on the Proponent for the design of such policies.		
Pre-Mitigation		
Moderate		

5.4.4.5 Significance of Impacts Post-Mitigation.

Based on the analysis provided above, the impact of labour, working conditions, and unfair recruitment practices will be a "**Minor Negative Impact**" post-mitigation (refer to Table 5-146),

Table 5-146: Rating of Impacts Related to Labour, Working Conditions, and Unfair Recruitment Practices Post-Mitigation.

Type of Impact
Direct negative impact
Rating of Impacts

Characteristic	Designation	Summary of Reasoning
Extent	Regional	While a large proportion of the workforce will be sourced locally, especially during construction phase, workers will also be sourced regionally and nationally.
Duration	Long-term	Potential impacts related to labour, working conditions, and recruitment practices are anticipated to last throughout the operational life of the asset.
Scale	Negligible	Effective implementation of labour and working condition policies in line with international standards can greatly mitigate the scale of this impact.
Frequency	Continuous	During all phases of the Project lifecycle, a workforce will be required for the Project, albeit at fluctuating levels across construction and operation.
Magnitude		
Small		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium		
High levels of poverty within the AoI suggest that unskilled labourers are vulnerable to potentially unfair recruitment practices and poor working conditions. The human rights context in Nigeria does not ensure governmental oversight regarding appropriate and safe labour policies and working conditions which respect human rights, placing the onus on the Proponent for the design of such policies.		
Post-Mitigation (Residual)		
Minor		

5.4.5 Impacts on Socio-Economic Environment from Unplanned Activities

5.4.5.1 Description of the Baseline Environment

Respondents within the AoI are 48,76% reliant on livelihood activities directly related to fishing or the processing of fish. As such, any potential Project impacts on natural resources (and particularly fishing resources) may have significant impacts on community livelihoods.

5.4.5.2 Proposed Project Activities

Potential unplanned contamination of fishing waters surrounding the Project site by pollutants such as diesel or cement during the construction phase, or urea or ammonia during the operational phase, may impact the viability of fishing waters used by local communities.

5.4.5.3 Sensitive Receptors

Communities using the waterway directly adjacent to the Project site will be sensitive to disruptions to fishing livelihood activities. This could include specifically Ele and Owo Ogono (Ogu communities, located on the west side of Port Onne) which are both fishing settlements.

5.4.5.4 Significance of Impacts Pre-Mitigation

Should there be an impact on fishing resources, it is likely that these communtiies will be most vulnerable, as it is likely to support the livelihoods (subsistence fishing) and household income (selling/processing fish). As such, the impact of an unplanned contamination of fishing waters will be a "**Moderate Negative Impact**" pre-mitigation (refer to Table 5-147*).*

Table 5-147: Rating of Impacts Related to Unplanned Contamination of Local Fishing Waters Pre-Mitigation.

Type of Impact		
Direct negative impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Unplanned contamination will likely be limited to fishing waters in the immediate vicinity of the Project prior to the identification and control of the unplanned contamination.
Duration	Medium-term	Without mitigation, there could be a medium-term impact on fishing industry and livelihoods, as it is assumed that it will take a number of years for natural processes to recover.
Scale	Medium	The scale will be equivalent to the area contaminated, should the unplanned event occur; however, the likely scale is considered to be moderately disruptive.
Frequency	Continuous	Access to fishing waters will be disrupted on a daily/ongoing basis.
Magnitude		
Medium		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium		
Local communities reliant on fishing livelihoods are likely economically vulnerable, and alternative livelihoods and income may be scarce.		
Pre-Mitigation		
Moderate		

5.4.5.5 Significance of Impacts Post-Mitigation

The impact of an unplanned contamination of fishing waters will be a "**Minor Negative Impact**" post-mitigation (refer to Table 5-148).

Table 5-148: Rating of Impacts Related to Unplanned Contamination of Local Fishing Waters.

Type of Impact
Direct negative impact

Rating of Impacts

Characteristic	Designation	Summary of Reasoning
Extent	Local	Unplanned contamination will likely be limited to fishing waters in the immediate vicinity of the Project prior to the identification and control of the unplanned contamination.
Duration	Short-Term	Assuming that Project controls are applied effectively, and clean-up of contaminated waters can be performed timeously, it is assumed the impact will be relatively short term.
Scale	Small	The scale will be equivalent to the area contaminated, should the unplanned event occur; however, with mitigation the scale could be reduced.
Frequency	Continuous	Access to fishing waters will be disrupted on a daily/ongoing basis.
Magnitude		
Small		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium		
Local communities reliant on fishing livelihoods are likely economically vulnerable, and alternative livelihoods and income may be scarce.		
Post-Mitigation (Residual)		
Minor		

5.4.6 Traffic Impact Assessment

5.4.6.1 Description of the Baseline Environment

Travel occurs by motorcycles/*kekes*, cars, light vans, and trucks on roads around and leading to the Project site. Buses are a small portion of the traffic. The Project site located at the Onne Port would receive urea and ammonia from the Indorama Complex located approximately 20 kilometres northeast. The area of the Project site would be accessed via newly constructed roadways, including the Project access road and West Africa Container Terminal (WACT)/ Onne Multipurpose Terminal (OMT) Road, that connect to the Federal Ocean Terminal (FOT) Road. The FOT Road is an asphalt-paved divided road with multiple lanes in each direction. On an average day, during daytime hours, the FOT Road in the location of the NPA Main Gate carries 5,456 vehicle trips.

The FOT Road leads to Onne Road—sometimes referred to as the Nigerian Ports Authority (NPA) Dual Carriage Way—an asphalt-paved, divided road with an unmarked paved width of about 8 m in each direction, and a 2 m concrete median. Traffic on Onne Road increases as it approaches East-West Highway.

Other major roads include the East West Highway and Indorama-Agbonchia-Ogale-Ebubu-East West Link Road (under construction), which will terminate at the Indorama complex. All of these roads are built to accommodate truck traffic, although pavement conditions vary.

The Project would export urea and ammonia from the Onne Port, which received 643 vessel calls in 2021 and 601 in 2022. Vessel traffic in Onne Port has averaged 49 vessels per month as of June 2023, which is similar to the 2022 average of 50 vessels per month.

5.4.6.2 Proposed Project Activities

The Project would include the construction and operation of a port terminal at Onne Port with all associated utilities for the export of urea and ammonia manufactured at the Indorama Petrochemical and Fertilizer complex in Eleme, Port Harcourt described in Chapter 4. The urea (granulated) will be transported along the East West Link Road in covered tipper trucks with 40 metric tonnes (MT) payload capacity, while liquid ammonia would be transported in dedicated tankers with 20 MT payload capacity.

The Project will include one vessel berth with a capacity to handle and export 1.4 MMTPA of granulated urea and about 150 KTA (approximately 420 MTPD) of ammonia.

5.4.6.2.1 Vehicle Traffic During Construction

Project activities generating vehicle traffic during construction would include the following:

- Employee transportation at the start and end of work shifts, provided primarily by bus and mini-bus. MM FZE estimates approximately 10 mini-buses and 2 buses would be needed per day, with a slight increase in buses during the peak in the earlier months and a lesser number as the construction phase winds down. Additionally, a total of 25 cars and pickup trucks would contribute to traffic during construction.
- Delivery of equipment, supplies, and components during construction would require an estimated 60 trucks daily during construction.
- Delivery of fuel and water would require an estimated 2 trucks daily during construction.

Construction of the port terminal and access road is estimated to take approximately 9 months. During construction, oversized and overweight truck transports would travel on East West Highway, Onne Road, the FOT Road, and newly constructed WACT/OMT and planned Project access roads on the route to the new Project site (Figure 1). Truck congestion in the port area will make these movements challenging, and oversized trucks may not be able to clear corners and traffic circles without encroaching on adjacent land. Personnel from the Federal Road Safety Corporation and Government Security will clear roads before an ODC convoy departs the port area and provide traffic control at narrow areas, cross-junctions and bridge crossings. MM FZE will coordinate with Port Harcourt Electricity Distribution Company to cut electrical power and disconnect cables that would obstruct high loads when needed. Where safe and feasible construction vehicles may travel at night to avoid higher daytime traffic volumes. Estimated construction traffic volumes are summarized by vehicle type in Table 5-149.

Table 5-149: Projected Vehicle Traffic during Construction.

Type of Vehicle	Peak Number / Day	Daily one-way trips
Cars & Pick-ups	25	50
Mini-bus	10	20
Bus	2	4
Trucks Dumpers	25	50
Trailers	10	20
Concrete Trucks	25	50
Diesel Tanker	1	2
Water Tanker	1	2
Total vehicle trips		**198**

Source: Indorama 2023

Vehicle Traffic During Operations

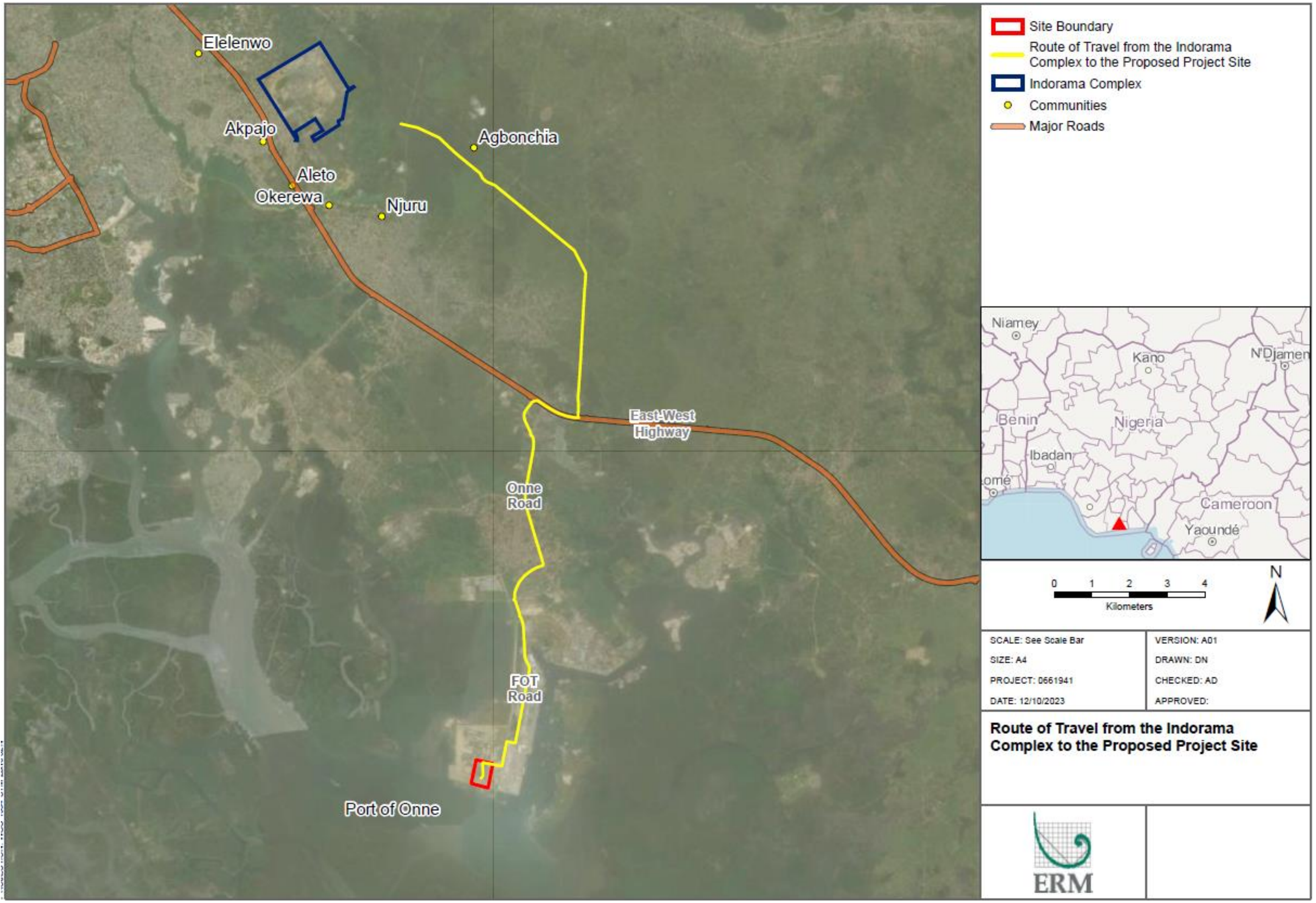
Once constructed, operations for the new port terminal would increase traffic by about 470 trips daily. These trips would include travel by workers, supplies, and the delivery of urea and ammonia from the Indorama Complex to the Project's new port terminal. The estimated daily traffic added by Project operations is summarised by vehicle type in Table 5-150.

Table 5-150: Projected Vehicle Traffic during Operations.

Type of Vehicle	Peak Number / Day	Daily one-way trips
Cars & Pick-ups	6	12
Mini-bus	4	8
Bus	1	2
Urea Trucks	200	400
Trailers	1	2
Diesel Tanker	1	2
CNG Trailer	1	2
Ammonia Tankers	21	42
Total vehicle trips		**470**

Source: Indorama 2023

Figure 5-6: Proposed Truck Route from Indorama Complex to Project Site



5.4.6.2.2 Vessel Traffic During Operations

The export of urea would require 30 vessels per year and the export of ammonia would require 6 vessels per year (Indorama 2023) adding up to 3 additional vessels per month (6 one-way vessel trips) to existing vessel traffic at Onne Port (assuming urea and ammonia are carried on separate vessels).

5.4.6.3 Sensitive Receptors

Receptors for the Projects transportation related impacts include users of and residents or business owners with property adjacent to the routes that would be used during Project construction and operation. Additionally, users of the Port of Onne and Bonny River would also be considered receptors. Receptor sensitivity is characterised as either Low, Medium, or High, based on the ability of these receptors to adapt to Project-related changes in road traffic volumes, degradation of road infrastructure, and transportation safety risk. Table 5-151 describes potential receptor sensitivity levels.

Table 5-151: Receptor Sensitivity to Transportation Impacts

Sensitivity	Low	Medium	High
Description	Receptors can easily adapt to Project vehicle and/or vessel traffic because they are accustomed to anticipated traffic volumes and heavy vehicle or vessel traffic, are comfortable sharing the road or sea with Project-related vehicles and vessels or are able to reach their destination using alternative routes not affected by Project traffic.	Somewhat frequent or regular users of the affected roads, and residents/business owners for properties impacted by Project traffic, but whose property is not adjacent to Project roads, or users of the Port of Onne and Bonny River.	Description

5.4.6.4 Significance of Impacts (Pre-mitigation)

This ESIA evaluates four types of transportation impacts related to Project construction, operation, and closure, as described below:

- Increased traffic congestion and delay due to Project-related vehicle trips during construction and operations. These impacts would primarily occur along the East West Highway, which connects the Project to the regional and national road network. These impacts could also occur on the Onne Road, FOT Road, and smaller network of roads which carry heavy truck traffic to the Project site at the Port at Onne.
- Increased deterioration of public roads due to Project-related vehicle trips, especially heavy vehicle trips during construction and operations.
- Increased risk of deaths, injuries, and property damage due to crashes involving Project vehicles on public roads during construction and operations. Due to their size, weight, and limited

manoeuvrability, trucks, buses, and other heavy vehicles are typically associated with more severe outcomes resulting from crashes.

- During operations, Increased vessel traffic congestion and delay at the Port of Onne and the Bonny River due to Project-related vessel trips.

Construction Phase

Traffic Operations

Employees commuting for Project construction would increase bus, mini-bus, and small vehicle traffic on the roads along the route from the Indorama Complex to the Project site at the Port of Onne. Combined traffic from cars, pick-ups, mini-bus, and bus would contribute an additional 74 daily trips to roadways. Heavy truck traffic would contribute an additional 124 daily trips. The increased traffic volume during construction would not add significantly to the existing traffic volume on East West Highway or Onne Road, but temporary delays and congestion could result from the movement of oversized truck loads and convoys between the East West Highway and the Project site. The combined 198 daily trips would increase daytime traffic volumes at the WACT/OMT Entrance of FOT Road (TC5, Table 4-39) by 9.5% (from 2,108 to 2,306 trips) and increase truck volume by 26% (from 471 to 595 trips). As a result, the Project construction impacts on traffic operations will be a "**Minor Negative Impact**" pre-mitigation (Table 5-152).

Table 5-152: Rating of Impacts Related to Traffic Operations during Construction Phase (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Project construction traffic would reach the Project site by using East West Highway, Onne Road, and FOT Road, and the Project's new access road at the Port of Onne. Prior to that point, Project traffic would disperse along other local and regional roads, at which point Project-related traffic volumes are unlikely to be discernible from the background traffic levels. As a result, the Project's primary effects on traffic construction would be localised.
Duration	Short-term	Construction would result in short-term impacts (nine months) on traffic volume and road congestion.
Scale	Locally Significant	Impacts would be most significant on East West Highway intersection with Onne Road. Periodic, short-term delays and congestion could result from construction-related oversized loads. The segment could experience delays due to employee vehicles queuing to turn from East West Highway onto the Onne Road during the morning commute, or during the evening commute as employee vehicles turn onto the East West Highway. Truck traffic would be distributed throughout the day and would add to already heavy truck volumes on the Onne Road and FOT Road, with potential for a minor increase in levels of congestion.

Frequency	Continual (Daytime hours)	Traffic would occur daily during Project construction.
Likelihood	Possible	Crashes, breakdowns, or other unplanned events involving Project vehicles on the roads could lead to road closures or partial blockages that result in temporary traffic congestion and delays.
Magnitude		
Small Magnitude on East West Highway and Onne Road. **Medium Magnitude on FOT Road due to increase in truck traffic**		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		
Residents and users of the East West Highway, Onne Road, and FOT Road would have low sensitivity. These road users are accustomed to high traffic volumes and heavy vehicles, but these routes are essential for regional truck and freight transport. Alternative routes for passenger vehicles, but not for trucks, are available.		
Significant Rating Before Mitigation		
Minor Impact		

Transportation Infrastructure

Project-related heavy truck traffic would result in incrementally faster wear and deterioration of road surfaces. The wear due to Project related construction vehicles would be most prominent on East West Highway, Onne Road, and FOT Road. Deteriorated road surfaces lead to delays, vehicle damage, increased risk of traffic incidents and stressful travel conditions. However, the expected nine-month construction period is a relatively short time frame. Additionally, the newly constructed WACT/OMT and planned Project access roads would provide a significant improvement in the road infrastructure. Based on the analysis provided above, it is anticipated that Project construction and operations would have a "**Minor Negative Impact**" to road infrastructure pre-mitigation (Table 5-153).

Table 5-153: Rating of Impacts Related to Traffic Infrastructure during Construction Phase (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Impacts would be on East West Highway approaching the intersection with Onne Road and on the roadways leading to the Project site.
Duration	Short-term	Construction would result in short-term impacts (nine months) on traffic infrastructure.
Scale	Locally Significant	Project construction traffic would contribute incrementally to road deterioration caused by the already heavy truck traffic volumes on the affected roads.

Frequency	Continual (Daytime hours)	Heavy vehicle traffic would occur throughout Project construction resulting in continual wear and deterioration of road surfaces.
Likelihood	Possible	Unplanned events are unlikely to change the Project's impact on road condition.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		
Road users are accustomed to the current, variable condition of the East West Highway and port access roads. Alternative routes for truck traffic are not available.		
Significant Rating Before Mitigation		
Minor Impact		

Transportation Safety

The East West Highway and port access roads have sufficient width to safely carry heavy vehicles; however, the risks of transportation-related deaths, injuries, and property damage generally rise along with the increase in traffic volumes, and especially the increase in truck traffic volumes. Project construction would result in limited additional risk to pedestrians because East West Highway and port access roads (Onne Road, FOT, and the newly constructed WACT/OMT and planned Project access roads) are not intended for use by pedestrians. The Project Traffic Survey Report identified a safety issue of concern for pedestrians trying to cross in the area of the Onne Road and FOT Road due to the reckless parking of trucks on both sides of the speed and service lanes.

Based on the analysis provided above, the Project construction would have a "**Minor Negative Impact**" on transportation safety pre-mitigation (Table 5-154).

Table 5-154: Rating of Impacts Related to Traffic Safety during Construction Phase (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Impacts would be on the East West Road and port access roads. Outside of the immediate planned route to the Project site, heavy vehicle traffic would be dispersed to regional and national highways and Project traffic safety impacts would not be discernible.
Duration	Short-term	Construction would result in short-term impacts (nine months) on traffic safety.

Scale	Locally Significant	A modest increase in road safety risk attributable to increased volume resulting from the Project could occur on segments of the East West Road and the port access roads.
Frequency	Continual (Daytime hours)	Increased vehicle traffic, including heavy trucks, would occur throughout Project construction.
Likelihood	Possible	Unplanned events such as crashes would substantially increase the Project's impact on transportation safety.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		
Road users are accustomed to high traffic volumes and heavy vehicles.		
Significant Rating Before Mitigation		
Minor Impact		

Operational Phase

Traffic Operations

Employees commuting for Project operation would not result in perceptible increases in traffic volumes, adding only an estimated 28 trips daily to the bus, mini-bus, and small vehicle traffic on the roads along the route from the Indorama Complex to the Project site at the Port of Onne. Delivery trucks and tankers carrying urea and ammonia from the Indorama Complex to the Project site would contribute 442 trips per day, a 94 increase over the average daily daytime truck trips at the WACT/OMT Entrance, which currently carries an average of 471 truck trips daily (Table 4-39). The urea and ammonia truck trips would also represent a 35% increase in truck trips at the FOT Road NPA Main Entrance Gate, and a 29% increase in truck trips at the Onne Road second roundabout.

Vessel traffic during operation would include the export of urea thirty times per year and ammonia six times per year . The combined three exports trips per month would be a 6% increase of in average monthly vessel traffic from 2022 and 2023.

Based on the analysis provided above, the impact from traffic operations will be a "**Moderate Negative Impact**" pre-mitigation (Table 5-155).

Table 5-155: Rating of Impacts Related to Traffic Operations during Operational Phase (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning

Extent	Local	Project operations traffic would reach the Project site by using East West Highway, Onne Road, and FOT Road, and the Project's new access road at the Port of Onne. Vessel traffic increases would be limited to Onne Port and the Bonny River. As a result, the Project's primary effects on traffic operations would be localised.
Duration	Long-term	Operations would continue for in yet to be determined amount of time, resulting in long-term impacts on traffic and vessel volume and road congestion.
Scale	Locally Significant	Project operations would result in a large (more than 29%) increase in truck traffic on the roadways from Onne Road second roundabout to the Project site and a minor (6%) increase in vessel traffic in Onne Port. Road impacts would be most substantial at the East West Highway intersection with Onne Road. Periodic delays and congestion could result from urea and ammonia delivery trucks going to and from the Project site. Truck traffic would be distributed throughout the day and would add to already heavy truck volumes on the Onne Road and FOT Road, with potential for increases in the levels of congestion. Vessel traffic increases in Onne Port and on the Bonny River would be noticeable.
Frequency	Continual	Traffic would occur daily during Project operations.
Likelihood	Possible	Crashes, breakdowns, or other unplanned events involving Project vehicles on the roads and vessels at port and at sea could lead to road closures, partial blockages, or marine restricted areas that result in temporary traffic congestion and delays.
Magnitude		
Medium Magnitude on East West Highway and Onne Road. **Medium to Large Magnitude on FOT Road due to increase in truck traffic.** **Medium magnitude for vessel traffic**		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low to Medium Sensitivity		
Residents and users of the East West Highway, Onne Road would have low sensitivity. These road users are accustomed to high traffic volumes and heavy vehicles, and the increase would not represent a large change in traffic volume. Residents and users of the FOT Road would have a medium sensitivity. These routes are essential for regional truck and freight transport. Alternative routes for passenger vehicles, but not for trucks, are available. Operators of non-Project vessels in Onne Port and on the Bonny River would have low (for operators of commercial vessels) to medium (for operators of other vessels) sensitivity. Professional vessel operators would be accustomed to large vessel traffic while other vessel operators would likely be less familiar or comfortable with such situations.		
Significant Rating Before Mitigation		
Moderate Impact		

Transportation Infrastructure

Project operations related heavy truck traffic impacts would be similar to what is expected during construction but with additional truck traffic over a much longer period of time, resulting in incrementally faster wear and deterioration of road surfaces. Project related vessels would access newly constructed port terminal infrastructure designed specifically for the Project.

Based on the analysis provided above, it is anticipated that Project operations would have a "**Minor Negative Impact**" to transportation infrastructure pre-mitigation (*Table 5-156*).

Table 5-156: Rating of Impacts Related to Traffic Infrastructure during Operational Phase (Pre-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Impacts would most often occur on East West Highway approaching the intersection with Onne Road and on the roadways leading to the Project site.
Duration	Short-term	Operations would result in long-term impacts on traffic infrastructure.
Scale	Locally Significant	Project operations traffic would contribute incrementally to road deterioration caused by the already heavy truck traffic volumes on the affected roads.
Frequency	Continual (Daytime hours?)	Heavy vehicle traffic would occur throughout Project operations resulting in continual wear and deterioration of road surfaces.
Likelihood	Possible	Unplanned events are unlikely to change the Project's impact on road condition.
Magnitude		
Medium Magnitude on road infrastructure. Small Magnitude on marine infrastructure		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low Sensitivity		
Road users are accustomed to the current, variable condition of the East West Highway and port access roads. Alternative routes for truck traffic are not available.		
Significant Rating Before Mitigation		
Moderate Impact		

Transportation Safety

Transportation safety during operations would be similar to construction. The additional delivery trucks and increase in overall traffic would most likely increase the risk of transportation-related deaths, injuries, and property damage in comparison to current conditions. The Project would increase vessel traffic at Port of Onne and Bonny River by seven vessels (14 trips) per month.

Based on the analysis provided above, the Project construction would have a "**Moderate Negative Impact**" on transportation safety pre-mitigation (*Table 5-157)*.

Table 5-157: Rating of Impacts Related to Traffic Safety during Operational Phase (Pre-Mitigation).

Type of Impact
Direct Negative Impact

Rating of Impacts

Characteristic	Designation	Summary of Reasoning
Extent	Local	Increase in heavy trucks and traffic overall, would be most prevalent on the East West Road and port access roads.
Duration	Short-term	Operations would result in long-term impacts on traffic safety.
Scale	Locally Significant	A modest increase in road safety risk attributable to increased volume resulting from the Project could occur on segments of the East West Road and the port access roads.
Frequency	Continual (Daytime hours)	Increased vehicle traffic, including heavy trucks, would occur throughout Project construction.
Likelihood	Possible	Unplanned events such as crashes would substantially increase the Project's impact on transportation safety.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
Road users are accustomed to high traffic volumes and heavy vehicles, but the large increase in trucks over current numbers are anticipated along the FOT and the Project site.		
Significant Rating Before Mitigation		
Moderate Impact		

5.4.6.5 Residual Impact (Post-mitigation)

Construction Phase

During the construction phase, the implementation of the proposed mitigation measures provided in Section 6.5 would not change the significance of the Project's impacts on traffic operations, transportation infrastructure, or safety. These impacts would remain "**Minor Negative Impacts**. Post-mitigation" (Table 5-158, Table 5-159, and Table 5-160).

Table 5-158: Rating of Impacts Related to Traffic Operations during Construction Phase (Post-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Project construction traffic would reach the Project site by using East West Highway, Onne Road, and FOT Road, and the Project's new access road at the Port of Onne. Prior to that point, Project traffic would disperse along other local and regional roads, at which point Project-related traffic volumes are

		unlikely to be discernible from the background traffic levels. As a result, the Project's primary effects on traffic construction would be localised.
Duration	Short-term	Construction would result in short-term impacts (nine months) on traffic volume and road congestion.
Scale	Locally Significant	Impacts would be most significant on East West Highway intersection with Onne Road. Periodic, short-term delays and congestion could result from construction-related oversized loads. The segment could experience delays due to employee vehicles queuing to turn from East West Highway onto the Onne Road during the morning commute, or during the evening commute as employee vehicles turn onto the East West Highway. Truck traffic would be distributed throughout the day and would add to already heavy truck volumes on the Onne Road and FOT Road, with potential for a minor increase in levels of congestion.
Frequency	Continual (Daytime hours)	Traffic would occur daily during Project construction.
Likelihood	Possible	Crashes, breakdowns, or other unplanned events involving Project vehicles on the roads could lead to road closures or partial blockages that result in temporary traffic congestion and delays.
Magnitude		
Small Magnitude on East West Highway and Onne Road. **Medium Magnitude on FOT Road due to increase in truck traffic**		
Significant Rating After Mitigation		
Minor Impact		

Table 5-159: Rating of Impacts Related to Traffic Infrastructure during Construction Phase (Post-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Impacts would be on East West Highway approaching the intersection with Onne Road and on the roadways leading to the Project site.
Duration	Short-term	Construction would result in short-term impacts (nine months) on traffic infrastructure.
Scale	Locally Significant	Project construction traffic would contribute incrementally to road deterioration caused by the already heavy truck traffic volumes on the affected roads.
Frequency	Continual (Daytime hours)	Heavy vehicle traffic would occur throughout Project construction resulting in continual wear and deterioration of road surfaces.
Likelihood	Possible	Unplanned events are unlikely to change the Project's impact on road condition.
Magnitude		
Small Magnitude		

Significant Rating After Mitigation
Minor Impact

Table 5-160: Rating of Impacts Related to Traffic Safety during Construction Phase (Post-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Impacts would be on the East West Road and port access roads. Outside of the immediate planned route to the Project site, heavy vehicle traffic would be dispersed to regional and national highways and Project traffic safety impacts would not be discernible.
Duration	Short-term	Construction would result in short-term impacts (nine months) on traffic safety.
Scale	Locally Significant	A modest increase in road safety risk attributable to increased volume resulting from the Project could occur on segments of the East West Road and the port access roads.
Frequency	Continual (Daytime hours)	Increased vehicle traffic, including heavy trucks, would occur throughout Project construction.
Likelihood	Possible	Unplanned events such as crashes would substantially increase the Project's impact on transportation safety.
Magnitude		
Small Magnitude		
Significant Rating After Mitigation		
Minor Impact		

5.4.6.5.1 Operations Phase

During the operations phase, the implementation of the proposed mitigation measures provided in Section 6.5 would reduce the significance of the Project's impacts on traffic operations and safety from "**Moderate Negative Impacts**" to "**Minor Negative Impacts**" (Table 5-161, Table 5-162, and Table 5-163).

Table 5-161: Rating of Impacts Related to Traffic Operations during Operational Phase (Post-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning

Extent	Local	Project operations traffic would reach the Project site by using East West Highway, Onne Road, and FOT Road, and the Project's new access road at the Port of Onne. Vessel traffic increases would be limited to Onne Port and the Bonny River. As a result, the Project's primary effects on traffic operations would be localised.
Duration	Long-term	Operations would continue for in yet to be determined amount of time, resulting in long-term impacts on traffic and vessel volume and road congestion.
Scale	Locally Significant	Project operations would result in a large (more than 25%) increase in truck traffic on the roadways from Onne Road second roundabout to the Project site and a large (14%) increase in vessel traffic in Onne Port. Impacts would be most substantial at the East West Highway intersection with Onne Road. Periodic delays and congestion could result from urea and ammonia delivery trucks going to and from the Project site, mitigated by traffic management measures. Vessel traffic increases in Onne Port and on the Bonny River would be noticeable but manageable.
Frequency	Continual	Traffic would occur daily during Project operations.
Likelihood	Possible	Crashes, breakdowns, or other unplanned events involving Project vehicles on the roads and vessels at port and at sea could lead to road closures, partial blockages, or marine restricted areas that result in temporary traffic congestion and delays. The likelihood would be reduced by traffic management measures.
Magnitude		
Minor Magnitude on East West Highway and Onne Road. Medium Magnitude on FOT Road due to increase in truck traffic. Small magnitude for vessel traffic		
Significant Rating After Mitigation		
Minor Impact		

Table 5-162: Rating of Impacts Related to Traffic Infrastructure during Operational Phase (Post-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Impacts would most often occur on East West Highway approaching the intersection with Onne Road and on the roadways leading to the Project site.
Duration	Short-term	Operations would result in long-term impacts on traffic infrastructure.
Scale	Locally Significant	Project operations traffic would contribute incrementally to road deterioration caused by the already heavy truck traffic volumes on the affected roads.
Frequency	Continual (Daytime hours?)	Heavy vehicle traffic would occur throughout Project operations resulting in continual wear and deterioration of road surfaces, mitigated by appropriate repairs.
Likelihood	Possible	Unplanned events may change the Project's impact on road condition.
Magnitude		

Small Magnitude on road infrastructure. Small Magnitude on marine infrastructure
Significant Rating After Mitigation
Minor Impact

Table 5-163: Rating of Impacts Related to Traffic Safety during Operational Phase (Post-Mitigation).

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	Designation	Summary of Reasoning
Extent	Local	Increase in heavy trucks and traffic overall, would be most prevalent on the East West Road and port access roads.
Duration	Short-term	Operations would result in long-term impacts on traffic safety.
Scale	Locally Significant	A small increase in road safety risk attributable to increased volume resulting from the Project could occur on segments of the East West Road and the port access roads.
Frequency	Continual (Daytime hours)	Increased vehicle traffic, including heavy trucks, would occur throughout Project operations.
Likelihood	Possible	Unplanned events such as crashes would slightly increase the Project's impact on transportation safety.
Magnitude		
Small Magnitude		
Significant Rating After Mitigation		
Minor Impact		

5.4.7 Cultural Heritage Impact Assessment

5.4.7.1 Description of the Baseline Environment

The baseline study for cultural heritage (Section 4.7) identified **three** Cultural Heritage resources, comprising **no** Designated Resource, and **three** Non-Designated resources within the Project AoI. Each resource was assigned a unique identifier (for example MM_CH_001) and comprise the following 'type' of resource:

- Shrines: (MM_CH_001, 002, and 003)

The sensitivity/value of receptor for the cultural heritage resources identified in the baseline has been assigned based on ERM's internal Impact Assessment Standard criteria for Cultural Heritage Impact Significance, professional judgement, desk-based research, and the field survey on tangible and intangible cultural heritage.

ERM's internal Impact Assessment Standard Criteria for Cultural Heritage Impact Significance is aligned with the IFC PS8 guidance, and assigns a 'Low', 'Medium' and 'High' value to cultural heritage resources as set out in **Table 5-164** below.

Table 5-164: Criteria for Cultural Heritage Sensitivity of Receptor (a guide)[14]

Cultural Heritage Resource Sensitivity		
Low	**Medium**	**High**
• Defining Characteristics: • Site is not specifically protected under local, national or international laws or treaties; • Site can be moved to another location or replaced by a similar site, or is a type of site that is common in the surrounding region; • Site has limited or no cultural value to local, national or international stakeholders; and/or • Site has limited scientific value or similar information can be obtained at numerous sites • (Replicable Cultural Heritage)	• Defining Characteristics: • Site is specifically or generally protected by local or national laws, but laws allow for mitigated impacts; • Site can be moved or replaced, or data and artefacts recovered in consultation with stakeholders; • Site has considerable cultural value for the local and/or national stakeholders; and/or • Site has substantial scientific value, but similar information can be obtained at a limited number of other sites. • (Non-replicable Cultural Heritage)	• Defining Characteristics: • Site is protected by local, national and international laws or treaties; • Site cannot be moved or replaced without a major loss of cultural value; • Legal status specifically prohibits direct impacts or encroachment on site and/or protection zone; • Site has substantial value to local, national and international stakeholders; and/or • Site has exceptional scientific value and similar site types are rare or non-existent • (Critical Cultural Heritage)

Each of the **three** cultural heritage resources are presented with a sensitivity in line with the ERM Impact Assessment Methodology[15]. Table 5-165 presents the 'types and quantities of identified cultural heritage resources in relation to their sensitivity of receptor. The distinction of high, medium, and low sensitivity is utilised in each impact assessment table.

Table 5-165 Quantities of High, Medium and Low Sensitivity of Receptor for Cultural Heritage 'types' Identified in the Baseline

'Type' of Cultural Heritage resource	**High Sensitivity**	**Medium Sensitivity**	**Low Sensitivity**
Shrines	0	0	3
Total	**0**	**0**	**3**

Give that there are no tangible cultural heritage resources within the direct footprint of the Project and that only low sensitivity cultural heritage resource types exist within the broader Project AoI, it can be concluded that the Project will not result in any impacts to cultural heritage resources during all Project phases (refer to Table 5-166).

[14] Source: Annex to The ERM Impact Assessment Standard)

[15] Source: Annex to The ERM Impact Assessment Standard

Table 5-166: Impacts on Identified Cultural Heritage Sites

Unique Identifier	Description/ Designation	Sensitivity	Direct/ Indirect	Construction Impact			Operation Impact		
				Nature of impact including Mitigation	Magnitude of Impact	Significance of Impact	Nature of impact including Mitigation	Magnitude of Impact	Significance of Impact
MM_CH_001	A shrine located within the Ele fishing settlement (Figure 51).	Low	No impact	n/a	n/a	n/a	n/a	n/a	n/a
MM_CH_002	A shrine and sacred location within the Owo-Ogono fishing community (Figure 52).	Low	No impact	n/a	n/a	n/a	n/a	n/a	n/a
MM_CH_003	A shrine tree representing a sacred deity and the gods of Ele-Ogu (Figure 53)	Low	No impact	n/a	n/a	n/a	n/a	n/a	n/a

5.4.8 Consideration of Hazard and Operability Risk

A Hazard Operability (HAZOP) Study of the ammonia process system was conducted by Toyo Engineering Cooperation with the objective of identifying hazards and operability issues that could have a significant impact on the design and operation of the Project, and whether there is a process deviation away from the safe operating envelope. The HAZOP study identified several causes that could lead to process deviation. It also provides an assessment of the consequences should there be a process deviation, as well as safeguards in place to prevent such events. The HAZOP study provided 63 recommendations/action items to improve the safety or the operability of the Project.

The main hazard associated with the Project is potential loss of ammonia containment. Loss of ammonia containment has the probability to result in high consequence incidents, due to ammonia being flammable and toxic, and given that it is often a compressed gas or liquefied gas. Loss of ammonia containment could occur during the following events:

- Leaks / failure.
- Overpressure or loss of pressure in ammonia storage tanks.
- Elevated temperature in ammonia equipment.
- Release from offloading road tankers.
- Release from ancillary equipment such as compressors, pipework, hoses, etc.

All of which the above events have the potential to release significant quantities of ammonia.

5.4.8.1 Effects of Accidental Release on Humans

An accidental release of ammonia from a particular system can result in a toxic vapour cloud. The size of the toxic cloud and area over which dangerous levels may be present depends on the release rate and duration. The effects on people exposed to the toxic cloud will depend on the concentration of the cloud and the duration of exposure, weather, and atmospheric conditions. People who are indoors will have some protection from the toxic cloud if they close all doors and windows and turn off any air conditioning. In addition to the accidental release of ammonia there are also risks associated with explosion events. The severity of the explosion could affect not only the staff of the plant but public as well.

Toxic release of ammonia can result in injury or in extreme cases death. If the concentration ammonia released is sufficiently high and the exposure is sufficiently long, then fatalities may result. The principal effects arising from a single exposure of humans to ammonia are exerted on the mucous membranes: sensory irritation of the eyes, nose and upper respiratory tract, and inflammation and necrosis of the respiratory tract epithelium, lung oedema and congestion. Mortality results from lung damage, and death occurs rapidly (within hours to a couple of days post-exposure), due to oedema and congestion, or secondary pneumonia.

5.4.8.2 Recommendations

The HAZOP study summarises various recommendations to ensure that equipment and operations work as designed. Some of the actions that should be considered and to minimise impact of accidents include:

- All plant operators should be suitably trained to manage ammonia releases as well as, where necessary, procedures to shut down ammonia equipment and where possible isolate areas of release.
- Employment entry and employment release medicals, yearly medicals for those that work in a volatile environment.
- Install gas detectors for early ammonia leak detection.
- Install pressure relief valves on storage vessels and at other locations in the ammonia system.
- Install water sprinkler deluge systems at the ammonia loading/offloading and storage area.
- Install sensors that are able to measure different concentrations of ammonia, which in turn activates alarm and sprinkler systems.
- Install evacuation alarms in high-risk areas.
- Develop a robust Emergency Response Plan for the Project that is specific for ammonia release. This plan should include emergency response procedures and drills should be periodically undertaken.

5.5 Summary of Impact Assessment

A summary of pre- and post- (residual) impacts is provided in Table 5-167.

Table 5-167 Summary of Physical, Biophysical and Socio-economic Environmental Impacts

Impact	Significance (pre-mitigation)
Physical Environment Impacts	
Impacts related to construction dust	Minor Negative Impact
Impacts related to construction traffic air quality	Negligible Impact
Impacts related to operational traffic on air quality	Negligible Impact
Impacts related to operation of the port air quality	Negligible Impact
Impacts related to bored piles installation on the geology	Minor Negative Impact
Impacts related to surface infrastructure installation on the geology	Minor Negative Impact
Impacts related to dredging on the geology during the construction	Minor Negative Impact
Impacts related to water supply wells installation on the geology	Minor Negative Impact
Impacts related to dredging on the geology during the operational	Minor Negative Impact
Impacts related to bored piles installation on the soils	Minor Negative Impact
Impacts related to surface infrastructure installation on the soils	Moderate Negative Impact
Impacts related to water supply wells installation on the soils	Minor Negative Impact

Impact	Significance (pre-mitigation)
Impacts related to vehicular use on the soils during the construction	Minor Negative Impact
Impacts related to vehicular use on the soils during the operational	Minor Negative Impact
Impacts related to saltwater intrusion on the groundwater	**Major Negative Impact**
Impacts related to bored pile installation on the groundwater	Minor Negative Impact
Impacts related to chemical and hydrocarbon spills on the groundwater	Moderate Negative Impact
Impacts related to saltwater intrusion on the groundwater	**Major Negative Impact**
Impacts related to transport, loading and storage of urea on the groundwater during operation	Moderate Negative Impact
Impacts related to transport, loading and storage of ammonia on the groundwater during the operation	Moderate Negative Impact
Impacts related to using seawater as fire water on the groundwater	Minor Negative Impact
Impacts related to sewage on the groundwater during the operation	Minor Negative Impact
Impacts related to dredging on the surface water during the construction	Minor Negative Impact
Impacts related to construction of surface infrastructure on the surface water	Minor Negative Impact
Impacts related to the water supply wells on the surface water during the construction	Minor Negative Impact
Impacts related to flood risk on the surface water during the construction	Negligible Negative Impact
Impacts related to dredging on the surface water resource during the operation	Minor Negative Impact
Impacts related to marine vessels on the surface water during the operation	Minor Negative Impact
Impacts related to the groundwater abstraction on the surface water	Minor Negative Impact
Impacts related to vehicular use on the surface water during the operation	Minor Negative Impact
Impacts related to flood risk on the surface water resource during the operation	Negligible Negative Impact
Biophysical Environment Impacts	
Pre-construction and construction impacts on indigenous flora and terrestrial habitats	Moderate Negative Impact
Pre-construction and construction impacts on indigenous terrestrial fauna and avifauna	Moderate Negative Impact
Operational Impacts on indigenous flora and terrestrial habitats	Moderate Negative Impact
Operational Impacts on indigenous terrestrial fauna and avifauna	Moderate Negative Impact
Unforeseen impacts on terrestrial biodiversity	**Major Negative Impact**
Impacts related to the direct loss of estuarine habitat and biota during construction	Minor Negative Impact
Impacts related to dredging on the estuarine habitat and biota during construction	Minor Negative Impact
Impacts related to general construction disturbance to avifauna	Moderate Negative Impact
Impacts related to dredging disturbance to avifauna during construction	Moderate Negative Impact
Impacts related to underwater construction noise on estuarine biota other than marine mammals	Minor Negative Impact
Impacts related to underwater construction noise on estuarine mammals	**Major Negative Impact**
Impacts related to changes in estuarine form and function	Negligible Negative Impact
Impacts related to changes in stormwater runoff due to construction	Minor Negative Impact
Impacts related to artificial light at night on estuarine biota on avifauna during operation	Moderate Negative Impact

Impact	Significance (pre-mitigation)
Impacts related to operation underwater noise on estuarine biota other than mammals	Moderate Negative Impact
Impacts related to operational underwater noise on estuarine mammals	Moderate Negative Impact
Impacts related to routine discharges from vessels	Minor Negative Impact
Unplanned events related to fuel spills and other pollution	**Major Negative Impact**
Impacts unplanned events related to spills of ammonia-derived products	**Major Negative Impact**
Impacts related to catastrophic loss of containment	**Major Negative Impact**
Socio-economic Impacts	
Impacts related to the economy and employment	Positive Impact
Impacts related to road safety risks	**Major Negative Impact**
Impacts related to communicable diseases, environmental health, and reduced access to healthcare facilities	Moderate Negative Impact
Impacts related to crime, conflict, security, and human rights	Moderate Negative Impact
Impacts related to the presence of a workforce and pressures on social resources	Moderate Negative Impact
Impacts related to the disruption of local subsistence livelihoods	Minor Negative Impact
Impacts related to unmet expectations of benefits	Moderate Negative Impact
Impacts related to labour, working conditions, and unfair recruitment practices	Moderate Negative Impact
Impacts related to unplanned contamination of local fishing waters	Moderate Negative Impact
Impacts related to traffic operations during construction	Minor Negative Impact
Impacts related to traffic infrastructure during operational phase	Minor Negative Impact
Impacts related to traffic safety during construction phase	Minor Negative Impact
Impacts related to traffic operations during operational phase	Moderate Negative Impact
Impacts related to traffic infrastructure during operational phase	Moderate Negative Impact
Impacts related to traffic safety during operational phase	Moderate Negative Impact

5.6 Cumulative Impact Assessment

5.6.1 Introduction

The IFC Performance Standard 1 (Paragraph 5) defines the broader Project area to include *"… areas potentially impacted by cumulative impacts from further planned development of the Project, any existing project or condition, and other project-related developments that are realistically defined at the time the Social and Environmental Assessment is undertaken."*

In addition, the IFC Performance Standard 1 (Paragraph 6) states that the *"… assessment will also consider potential trans-boundary effects, such as pollution of air, or use or pollution of international waterways, as well as global impacts, such as the emission of greenhouse gases."*

Cumulative impacts are those impacts that act together with other impacts (including those from concurrent or planned future third-party activities) to affect the same resources and/or receptors as the Project. Cumulative impacts are therefore generally impacts that act with others in such a way that the sum is greater than the parts. This is, however, not always the case – sometimes they will simply be the sum of the parts, but that sum becomes significant.

In practice, effective design and implementation of a complete Cumulative Impact Assessment processes is beyond the technical and financial capacity of a single developer. This is particularly true since a single developer will not have authority on other developers within the region. Cumulative Impact Assessments must be conducted and implemented with the authorities associated with developments, and are multi-stakeholder, iterative processes that:

- Require the involvement of multiple multi-disciplinary teams and an effective, efficient governance structure; and
- Tend to be time and data intensive.

This Section provides a qualitative description of the cumulative impacts that would result from the combination of the proposed MM FZE Project, and *other* actual or proposed future developments in the broader Project Area.

5.6.2 *Development Context*

In addition to what has already being assessed, the Project may experience cumulative impacts as a result of –

- Existing operations at the Indorama Complex consisting of two trains of 2,300 MTPD of Ammonia and 4,000 MTPD of Urea and associated Line 3 expansion (2,300 TPD of Ammonia and 4,000 TPD of and Urea).
- Greater Port Harcourt City Development Plan – this includes the development of a residential, commercial, and industrial urban area to the north of the city as an extension of the Old Port Harcourt City, which will allow for urban growth and de-densification Port Harcourt. The necessity for a master development plan was borne out of the constant population influx into the area and rapid physical expansion of Port Harcourt, resulting in uncontrolled development, poor living conditions for residents, and continuing deterioration of existing infrastructure.
- Existing OIS Indorama Port
- Reopening of revamped Port Harcourt refinery by Nigerian National Petroleum Corporation (NNPC), although delays are expected.
- The Bonny River has been subjected to intense sand mining/dredging and other over several years.
- MM FZE is proposing to develop a Methanol Project within the area.

5.6.3 Identified Cumulative Impacts

The cumulative impacts that would result from a combination of the Project and other actual or proposed future developments in the broader Study Area include:

- Geology and Soils
- Groundwater

- Surface Water
- Biodiversity
- Socio-economic

5.6.3.1 Geology and Soils

Due to the shallow nature of excavations that will take place and low sensitivity of the local geologic formation, no significant cumulative impacts on the geology are expected. Impacts from the proposed Project operations include soil erosion and loss of topsoil due to site preparation and de-vegetation, soil compaction due to increased vehicular movement on site, soil contamination due to hydrocarbon and chemical spills, and changes in the soil-water balance due to compaction. Activities on neighbouring properties could also have some impacts on the soils of the area (development property and surrounds). However, no significant cumulative impacts are expected.

5.6.3.2 Groundwater

There can be cumulative impacts on both the groundwater volume and the groundwater quality.

Groundwater abstraction from existing, or future, groundwater supply wells on neighbouring properties can contribute to the depletion of the groundwater resource in the broader Project area. This can lead to an increase in the vertical drawdown in groundwater level, as well as the extent of the zone of influence of the groundwater level drawdown in the area, especially in the case where the zone of influence of individual well overlap.

The groundwater qualities as described in Chapter 4 of this report show that the sodium and chloride concentrations in the aquifers are already somewhat elevated, although not to the same level as the surface water in the Bonny River. Sodium and chloride concentrations in the Bonny River is measured to range around 3,500 mg/L and 6,200 mg/L respectively, while the sodium and chloride concentrations in the aquifers are measured to be in the order of 10 – 280 mg/L and 20 – 700 mg/L respectively.

Increased saltwater intrusion due to groundwater abstraction from multiple properties will increase the negative impact on the groundwater qualities.

5.6.3.3 Surface Water

Numerous activities from oil and gas companies, import and export logistics, sand mining/dredging, and waste dumping occur in, and around, the Bonny River. These activities already impact both the stream flow volumes, and the river water quality in the Bonny River.

It is expected that impacts from the proposed Indorama Meliora port activities will merge with the existing impacts to form cumulative impacts on the river flow volumes, flow characteristics, and water qualities.

Ongoing port expansion at Port Onne, of which the Project site is part of, and the wider Bonny River channel over time will lead to an increase in loss of and degradation of mangrove habitats, associated reduction in regeneration of fish stocks and displacement of fauna. However, the Bonny River and its associated mangroves is only one of several extensive mangrove ecosystems within the Niger Delta. The expansion and development of Onne Port is further part of the Bonny River management plan. With mitigation as proposed above, the contribution to cumulative impacts in the Bonny River terrestrial habitats by the Project's construction and operation is anticipated to be of Minor to Negligible significance.

5.6.3.4 Biodiversity

Anthropogenic activities can result in numerous and complex effects on the natural environment. While many of these are direct and immediate, the environmental effects of individual activities or projects can interact with each other in time and space to cause incremental or aggregate effects. Impacts from unrelated activities may accumulate or interact to cause additional effects that may not be apparent when assessing the activities individually. Cumulative effects are defined as the total impact that a series of developments, either present, past or future, will have on the environment within a specific region over a particular period of time (DEAT IEM Guideline 7, Cumulative effects assessment 2004).

The Project is located on already busy area of the Bonny River Estuary, alongside the Onne Port and downstream of the highly populated areas surrounding Port Harcourt. This area is part of the Niger Delta, which has become known for frequent oil spills, pollution and the invasion of Nypa palm (Davies and Ugwumba 2013, Barenblitt et al. 2023).

The existing neighbouring port will create many of the same impacts predicted for this Project. These include dredging, noise impacts associated with vessel traffic, light pollution, and accidental pollution of fuels and litter. The confounding effect of the impacts of this Project as well as those of the existing Port will create a greater impact effect. Organisms already experiencing stress due to the impacts on the estuary may come to experience intolerable levels of physiological stress, which could have population-level effects.

5.6.3.5 Socio-economic

Activities associated with the proposed project that may result in cumulative impacts on the social and economic environment.

Positive impacts could include cumulative economic and employment benefits. The development of additional port facilities, and associated infrastructure could potentially lead to the broader economic development of the area, resulting in higher opportunities for local communities to have access to income (indirect through services and other development support businesses), improved infrastructure and access to a broader range of opportunities within the local area.

Negative impacts could include unplanned events. Firstly, elevated contamination of river water through loss of containment, fuel or oil spillage of one or more port activities, if not collectively managed. This could lead to disruption to fishing livelihoods for local communities. Secondly, reduced community health and safety through the addition of another port activity, which could add additional pressure onto social and public infrastructure, including roads, healthcare, housing and access to basic services. This could relate to the cumulative use of roads by heavy vehicles, and cumulative influx of job seekers and workers into the area. The current state of public and social services is considered low to moderate, and so new activities, and any future activities, are likely to have an additional impact and increase public risk and exposure to accidents and reduce access to basic needs and public services.

5.6.4 Holistic Management of Cumulative Impacts

The following measures will help to holistically mitigate and manage cumulative impacts:

- **Undertaking a Strategic Regional Environmental and Social Impact Assessment** – a strategic regional impact assessment would allow a comprehensive assessment of potential impacts that may result from MM FZE operations in the region together with other developments within the broader Study Area. This type of assessment would consider the cumulative impacts associated with the presence of developments and would prevent isolated and iterative decision-making. The assessment would require greater integration and planning by private developers and should be led by the Government of Nigeria. Such an assessment would ideally feed into combined and issue-specific mitigation and enhancement measures.
- **Revenue Management** – the Project and developments in the region will generate revenue for the local, regional, and national government through taxes and royalties. The extent that this revenue is invested and used productively (by national or regional government) back into the Study Area and surrounds would determine the extent to which local infrastructure and resources will be provided to manage a range of social and environmental impacts effectively. Developers / Operators in the area should combine to lobby the Nigerian Government for a systematic system of revenue recording and management that would enable directing benefits back to the region.
- **Regional Forum** – the establishment of a Regional Forum, where companies in the area can share lessons learnt, align strategies, and agree coordinated approaches to responding to social and environmental issues, will help to improve cooperation in managing stakeholder (including community) expectations, avoid setting bad precedents and improve ways in the pursuit of joint goals for sustainable development.
- **Data Sharing** – a data sharing agreement should be setup with other developers/operators in the region to share operational monitoring data. Data should be shared with regulators and interested stakeholders to allow cumulative impacts to be documented and to inform adaptive operational management.

5.6.5 Implications of Uncertainty

The cumulative environmental and social impacts described in this Chapter were assessed on the basis of the information available at the time and using information made available to ERM. The cumulative impact assessment has a certain level of uncertainty, which is inevitable with a study of this type.

CHAPTER – SIX

6. MITIGATION AND MANAGEMENT MEASURES

6.1 Introduction

This Chapter details potential mitigation measures to avoid, minimise, reduce, remedy, or compensate for potentially negative impacts, and enhance potential benefits of the Project. The development of mitigation/management measures and the management of residual impacts are further described in the Environmental and Social Management and Monitoring Plan (ESMMP) (refer to Chapter 7 and **Appendix A**).

This Chapter presents mitigation measures for the physical environment (*Section 6.2*), biological environment (*Section 6.3*) and the socio-economic environment (*Section 6.4*).

6.2 Physical Environment – Mitigation and Management Measures

6.2.1 Climate Change

This Section (and more specifically Table 6-1) provides high-level mitigation/management measures for the Project to consider in planning for both construction and operation.

Table 6-1: Mitigation/Management Measures for Climate Change.

Risk	*Phase*	*Mitigation/Management Measures*
Flooding and wildfires may lead to delays in construction and operations, and damage to equipment, infrastructure, structures, buildings, onsite fuel storage facilities, electrical aspects, etc.	Construction Operation	**Flooding** – assess potential flood risk and determine if additional flood defense measures are required, for example, raised platforms for equipment, sandbags to stop flood waters entering buildings, extra drainage, or barriers to divert flood waters. Vulnerability to flooding will vary depending on location. Implementing mitigation measures, such as flood defenses, can significantly reduce the risk of damage to equipment, infrastructure, electricity storage units etc. Ensure an emergency evacuation policy is in place, and staff are trained and practice drills. **Wildfires** – ensure a fire policy is in place, and staff are trained and practice drills. Training staff on fire risk is important and can significantly improve safety and awareness reducing the overall risk.
Prolonged and more frequent dry periods result in higher	Construction	Limit water use during the year. The benefit of this would need to be balanced against the costs in terms of reducing water

Risk	Phase	Mitigation/Management Measures
water consumption for construction and operations.	Operation	capacity which will be needed for construction and operations throughout the year. If the site has not yet worked with the local authority to determine risks, it is possible that water issues will become chronic over time and the Project should consider a long-term plan for dealing with these issues.
Impacts on health and safety for workers, resulting in health issues and restricted working hours.	Construction Operation	Ensure an occupational health and safety (OHS) policy is in place, and staff are trained and practice requirements, especially for extreme temperature conditions, drought, wildfires and for heavy rainfall conditions. The health and safety of staff is important and relatively small adjustments to patterns could significantly reduce the risk of negative outcomes.
Extreme heat may cause overheating to power generation systems, electrical power disruption network and substations.	Construction	Temperature sensitive electrical infrastructure / equipment should be identified initially to determine what impacts this might have on construction and operations. This should be completed through a review of all major operating electrical infrastructure / equipment at the site, using its key specification. Once this is completed, a review should be completed which considers the different ways to cool the electrical infrastructure / equipment to deliver the same outcome (for example through air or water cooling). If the specific electrical infrastructure cannot be cooled in this way, then an alternatives analysis should be completed to determine other options for achieving the same outcome. It is not possible to prevent overheating to power generation systems, electrical power disruption network and substations from occurring, but by regularly having workers checking on the condition of the electrical infrastructure / equipment, this increases the chance of any early-stage damage or stress being identified and therefore repaired. This in turn minimises the risk and costs.

6.2.2 Air Quality

The impact assessment identified that without mitigation the impacts associated with air quality were not of major significance. Table 6-2 below provides an overview of general mitigation/management measures that the Project should consider in planning for construction. There are no mitigation measures for flaring during operation as the modelling concluded that the flaring emissions will be of negligible impact.

6.2.2.1 Mitigation/Management Measures

Table 6-2: Mitigation/Management Measures for Air Quality.

Issue	Phase	Mitigation/Management Measures
Site Planning	Construction	• Increase frequency of site inspection by the person accountable for dust issues on site when activities with a high potential to produce dust are being carried out and during prolonged periods of dry or windy conditions. • Develop and implement a stakeholder communications plan that includes engagement with local businesses operating in the existing port before work commences on site. • Display the name and contact details of the person accountable for air quality and dust issues on the site boundary (i.e., the environment manager/engineer or site manager). • Cover, seed, or fence stockpiles to prevent wind whipping. • Avoid bonfires and burning of waste materials. • Plan Project layout so that machinery and dust causing activities are located as far away from receptors as possible. • Consider fences and enclosures around specific operations where there is a high potential for dust production and the site is active for an extensive period. • Limit site runoff (of water or mud) to prevent egress of material to other areas, which can create dust emissions when dried. • Keep site fencing, barriers and scaffolding clean using wet methods. • Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site cover them. • Reduce vehicle speed limits to as low as reasonably possibly, especially on unsurfaced haul roads and work areas (if long haul routes are required these speeds may be increased with suitable additional control measures provided). Implement awareness training for drivers.
Dust generation during earthworks	Construction	• Re-vegetate or hard stand earthworks and exposed areas and open soils to stabilise surfaces as soon as practicable. • Limit excavations/soil stripping to only sites for construction • Use Hessian, mulches or tackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable
Dust generation during concrete and	Construction	• Avoid scabbling (roughening of concrete surfaces) if possible. • Ensure sand and other aggregates are stored in bunded areas and are not allowed to dry out, unless this is required for a

Issue	Phase	Mitigation/Management Measures
other construction works		particular process, in which case ensure that appropriate additional control measures are in place. • Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery. • For smaller supplies of fine powder material ensure bags are sealed after use and stored appropriately to prevent dust.
Track out on Hard standing Public Roads	Construction	• Use water-assisted dust sweeper(s) on hard standing access and local roads, to remove, as necessary, any material tracked out of the Project site. • Avoid dry sweeping of large areas. • Ensure vehicles entering and leaving the Project site are covered to prevent escape of materials during transport. • Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable. • Implement a wheel washing system (with rumble grids to dislodge accumulated dust and mud prior to leaving the Site where reasonably practicable). • Install hard surfaced haul routes, which are regularly damped down with fixed or mobile sprinkler systems, or mobile water bowsers and regularly cleaned.

6.2.2.2 Monitoring Measures

- Undertake visual inspections noting events and activities producing visible dust emissions, and action to reduce these emissions as far as practicable.
- Record all dust and air quality complaints, identify cause, take appropriate measures to reduce emissions in a timely manner and record the measures taken.
- Record any exceptional incidents that cause dust and/or air emissions, either on- or off- site and the action taken to resolve the situation in the logbook.
- Record all inspections of haul routes and any subsequent action in a site logbook.

6.2.3 Noise

As detailed in *Section 5.6.4*, the predicted magnitude of airborne noise impacts during both construction and operations are anticipated to be negligible at NSRs in the immediate vicinity of the Project Area.

As such, other than general noise mitigation and management measures included in the ESMMP, no further mitigation or design changes are proposed for the Project.

Mitigation for impacts associated with increased underwater noise are discussed in Section 6.3.2.

6.2.3.1 Monitoring Measures

It is recommended that compliance monitoring be undertaken on a regular basis (weekly) at Project Site and monthly via direct measurement at Owo Ogono community. In the event of an exceedance of the criteria are identified, a Noise Management Plan (NMP) needs to be implemented to investigate the cause of the noise source and implement corrective actions to minimise the impact.

6.2.4 Geology

As detailed in Section 5.6.4, the sources of predicted impacts associated with geology include bored piles installation, construction of surface infrastructure, dredging and water supply well installation. Table 6-3 provides an overview of mitigation/management measures that the Project should consider in planning for both construction and operation.

6.2.4.1 Mitigation/Management Measures

Table 6-3: Mitigation/Management Measures for Geology.

Issue	*Phase*	*Mitigation/Management Measures*
Drilling and removal of sand during piling	**Construction**	• The area where bored piles will be installed will be minimised based on design by a competent person.
Excavations during construction	**Construction**	• Excavations will be minimised and restricted to the soil zone to prevent impacts on the geology. • Reduce the footprint of infrastructure built, and paving installed, on site
Dredging and removal of sand	**Construction**	• Impacts will be reduced by minimising the dredged area and the depth of dredging whilst still taking into consideration safe berthing of ships.
Limited water supply	**Operation**	• Base the well locations on results from a ground geophysical survey to increase the likelihood of success in terms of the yield of the well, and therefore reduce the number of wells that will be required. • Actively manage and optimise the well depth by a competent person (hydrogeologist) on site during the drilling process.

6.2.5 Soils and Land Use

As detailed in Section 5.6.5, the sources of predicted impacts associated with soils and land use include bored piles installation, construction of surface infrastructure, water supply well installation and vehicular activity on site. Table 6-4 provides an overview of mitigation/management measures that the Project should consider in planning for construction.

6.2.5.1 Mitigation/Management Measures for Planned Events

Table 6-4: Mitigation/Management Measures for Soils and Land Use.

Issue	*Phase*	*Mitigation/Management Measures*
Compaction of surface soil by vehicles, or loosening of the structure	Construction	• Reduce the area where piles are to be installed based on competent person design. • Reduce the number of vehicles present on site.
Soil disturbance due to excavations	Construction	• Land clearance should only be undertaken immediately prior to construction activities taking place there. • The footprints for all construction areas and areas for associated infrastructure (viz. equipment laydown areas, etc.) should be restricted to the minimum feasible extent with measures implemented to avoid footprint creep.
Contamination of soils during construction	Construction	• Areas where spillage of soil contaminants occurs should be excavated (to the depth of contamination) removed and suitably rehabilitated. If any other minor spillage occurs the spillage should be cleaned immediately, and the contaminated area should be rehabilitated. All contaminated material should be suitably disposed of. • Contractors and applicable Project staff should be trained regarding proper methods for transporting, transferring, and handling hazardous substances that have the potential to impact soil resources. • Hazardous waste storage areas should be provided with secondary containment. Moreover, hazardous waste should be stored in sealed / covered containers to prevent rainwater intrusion. • Dispose of oil, cleaning fluids, used parts / spares, other contaminated material such as rags to the appropriately approved waste disposal sites. • All dangerous and hazardous material stores and handling areas should be provided with secondary containment capable of holding 110% of the total capacity of all tanks / vessels. • The loading and unloading of dangerous and hazardous material should be confined to areas that are provided with secondary containment and in line with hazardous material handling procedures.
Increased vehicular traffic	Construction	• Reduce the number of vehicles present on site. • Perform vehicle maintenance in designated areas.

Issue	Phase	Mitigation/Management Measures
		• The Project should prevent any ad hoc maintenance of vehicles / equipment in and around the Project Area. All vehicles/ equipment should be maintained at a designated workshop. The workshop should include an oil/grease trap.

6.2.5.2 Monitoring Measures

Monitoring measures include:

Pre-construction and Construction Phases

- Monitor the number of vehicles and vehicular movement on site to limit disturbance during installation of the bored piles, construction of the surface infrastructure, and installation of the water supply wells.
- Monitor the storage of chemicals and hazardous materials such that they are stored in appropriately designed and managed containment areas or containers.
- Monitor the depth of excavation and restrict it to the soil zone where possible.
- Record as-built paved areas (area and size).
- Monitor surface soil erosion during and after rainfall events.
- Record and control handling, storage and proper disposal of oil, cleaning fluids, used parts / spares, other contaminated materials such as rags, and chemicals.
- Inspection that there is no ad hoc servicing of vehicles that could lead to spills onto unpaved areas and contamination of the soil will be prohibited.
- Monitor the adherence of proper cleanup procedures after accidental spills or contamination of the soil.

Operational Phase

- Monitor the number of vehicles and vehicular movement on site to limit disturbance during execution of tasks.
- Monitor the storage of chemicals and hazardous materials such that they are stored in appropriately designed and managed containment areas or containers.
- Monitor surface soil erosion during and after rainfall events.
- Record and control handling, storage and proper disposal of oil, cleaning fluids, used parts / spares, other contaminated materials such as rags, and chemicals.
- Inspection that there is no ad hoc servicing of vehicles.
- Monitor the adherence of proper cleanup procedures after accidental spills or contamination of the soil.

6.2.6 Groundwater

As detailed in Section 5.6.6, the sources of predicted impacts associated with groundwater include groundwater abstraction, bored piles installation and chemical and hydrocarbon spills. Table 6-5 provides an overview of mitigation/management measures that the Project should consider in planning for both construction and operation.

6.2.6.1 Mitigation/Management Measures

Table 6-5: Mitigation/Management Measures for Groundwater.

Issue	*Phase*	*Mitigation/Management Measures*
Groundwater abstraction from groundwater supply wells	Construction Operation	• The groundwater abstraction from each water supply well should be managed to minimise the vertical drawdown of the groundwater level within each well. The aim is to prevent the zone of influence of the groundwater level drawdown cone from reaching the Bonny River, or any other existing water supply wells on neighbouring properties. • The sustainable yield of each of the water supply wells should be determined from aquifer test results. The aquifer tests should be done in compliance with international best practice guidelines and include at least: • Calibration / step test, which entails at least 3 x 1-hour steps on increasing yield followed by recovery at the end of the 3 steps. The groundwater level depth should be monitored at a regular interval, preferably with a continuously (30 second interval) measuring level logger. • A 24-hour constant rate test during which a constant volume of wate should be pumped from the well. The pumping rate should be determined from the calibration / step test phase. The groundwater level should be monitored at a regular interval, preferably with a continuously (30 second interval) measuring level logger. • Recovery of the groundwater level in the well should be measured after completion of the 24-hour constant rate pumping phase. The recovery of the groundwater level should be monitored until 90 % recovery is reached, or 24 hours, whichever comes first. • A pumping schedule should be designed that aims to supply the required water volume, but also minimises the groundwater level drawdown in each of the wells. Preferably, the wells should not be pumped continuously for 24 hours per day, 7 days per week. Rather, a schedule should be

Issue	*Phase*	*Mitigation/Management Measures*
		developed where the groundwater level will be allowed to recover to natural, or near natural level, before pumping resumes. Allowing the groundwater level to recover in the well will minimise the extent of the drawdown cone, which in turn will minimise the possibility of salt water being drawn from the Bonny River towards the water supply wells and the resultant impact of saltwater intrusion on the aquifers. This schedule should be developed by a qualified hydrogeologist. • The water supply wells should be located as far as possible from the Bonny River, as well as other existing water supply wells on neighboring properties, in order to reduce the possibility of saltwater intrusion from the Bonny River. • Groundwater monitoring wells should be installed close to the river, in the area between the water supply wells and the Bonny River, to monitor changes in groundwater level, and sodium and chloride concentrations. Sodium and chloride will act as indicators of saltwater intrusion from the Bonny River into the aquifers.
Installation of bored piles disrupting groundwater flow patterns.	**Construction**	• The impact on flow patterns should be minimized by minimizing the area covered by the installed piles.
Contamination of the aquifers from chemical and hydrocarbon spills.	**Construction**	• Indicators for saltwater contamination, which include sodium (Na) and chloride (Cl), should be monitored. • Water quality should be compared to guidelines specified in the Nigerian Standard for Drinking Water Quality (Standards Organisation of Nigeria, 2015). The guideline limits are 200 mg/L for sodium and 250 mg/L for chloride. • In the case where the concentrations increase, then management system should be put in place to prevent further increase. This could include using other sources of water with lower sodium and chloride concentrations. • Note, the sodium and chloride concentrations in the aquifers are currently measured to be in the order of 10 – 280 mg/L and 20 – 700 mg/L respectively. These concentrations are near the water quality guidelines. It could be necessary to apply for exemption, or relaxation, of the guidelines as part of the necessary permit required from National authorities.

Issue	Phase	Mitigation/Management Measures
Contamination of the aquifers from Sewage	Operation	• Implement a groundwater quality Management and Monitoring plan. In the case where the concentrations do increase, then the concentrations are to be managed to remain below the water quality guidelines specified in the Nigerian Standard for Drinking Water Quality (Standards Organisation of Nigeria, 2015).

6.2.6.2 Monitoring Measures

Pre-construction and Construction Phases

- Monitor the groundwater quality for indications of contamination originating from hydrocarbon and chemical spills during the construction of surface infrastructure, installation of bored piles, and installation of the water supply wells. The quality guidelines include:
- WBG EHS Guidelines for Nitrogenous Fertilizer Production (2007) .
- Nigerian Standard for Drinking Water Quality (Standards Organisation of Nigeria, 2015).
- Monitor the depth of excavation during construction of surface infrastructure and restrict it to above the groundwater table, where possible.
- The handling and storage of chemicals and hazardous material will be monitored and controlled. Chemicals and hazardous materials will be stored in appropriately designed and managed containment areas or containers.
- Positioning and design of the water supply wells to be coordinated by a competent hydrogeologist to ensure minimum risk of saltwater intrusion.
- The groundwater abstraction from each water supply well will be managed to minimise the vertical drawdown of the groundwater level within each well. The abstraction schedule as designed by a competent hydrogeologist based on proper aquifer testing data will be implemented and recorded. The recorded data will be included in a groundwater monitoring report that comply with the requirements for submittal the authorities.
- The change in groundwater levels on site in response to the groundwater abstraction will be monitored. Monitoring wells will be installed in the area between the water supply wells and the Bonny River to monitor the groundwater levels. These wells will also be used to monitor the groundwater quality for saltwater intrusion from the Bonny River.
- A groundwater quality monitoring program should be implemented to monitor the groundwater quality for indications of contamination originating from the use of saltwater that is taken from the Bonny River, as fire water.
- A groundwater quality monitoring program will be implemented to monitor the groundwater resource for indications of contamination originating from the sewage infrastructure. Indicators for

sewage contamination include faecal indicator bacteria, including coliform bacteria, *Escherichia coli* (E.Coli), *Enterococcus* and *Streptococcus* spp.

Operational Phase

- A groundwater quality monitoring program will be implemented to monitor the groundwater quality for indications of contamination originating from the transport, off-loading, handling, storage, and loading for export, of urea and ammonia. The groundwater quality will be analysed for the presence of contaminant indicators, increasing trends in the indicator parameters, and compared to the relevant water quality standards. Where elements exceed the quality guidelines, or where increasing trends are identified, management and mitigation should be explored and implemented. The quality guidelines include:
  - WBG EHS Guidelines for Nitrogenous Fertilizer Production (WBG, 30 April 2007).
  - Nigerian Standard for Drinking Water Quality (Standards Organisation of Nigeria, 2015).
  - Contaminant indicators include nitrate (NO3), and ammonia (NH3).
- The handling and storage of chemicals and hazardous material will be monitored and controlled. Chemicals and hazardous materials will be stored in appropriately designed and managed containment areas or containers.
- A groundwater quality monitoring program will be implemented to monitor the groundwater quality for indications of contamination originating from the use of saltwater that is taken from the Bonny River, as fire water.
- A groundwater quality monitoring program will be implemented to monitor the groundwater resource for indications of contamination originating from the sewage infrastructure. Indicators for sewage contamination include faecal indicator bacteria, including coliform bacteria, *Escherichia coli* (E.Coli), *Enterococcus* and *Streptococcus* spp.
- The groundwater abstraction from each water supply well will be managed to minimise the vertical drawdown of the groundwater level within each well. The abstraction schedule as designed by a competent hydrogeologist based on proper aquifer testing data will be implemented and recorded. The recorded data will be included in a groundwater monitoring report that comply with the requirements for submittal the authorities.
- The change in groundwater levels on site in response to the groundwater abstraction will be monitored. Monitoring wells installed during the construction phase in the area between the water supply wells and the Bonny River will be used to monitor the groundwater levels. These wells will also be used to monitor the groundwater quality for saltwater intrusion from the Bonny River.

6.2.7 Surface Water

As detailed in Section 5.6.7*,* the sources of predicted impacts associated with surface water include dredging, water supply well installation and groundwater abstraction, increased vehicular movements, earthworks, and paving of the road surface. Table 6-6 provides an overview of mitigation/management measures that the Project should consider in planning for both construction and operation.

6.2.7.1 Mitigation/Management Measures

Table 6-6: Mitigation/Management Measures for Surface Water.

Issue	*Phase*	*Mitigation/Management Measures*
Change in the river channel and flow characteristics due to dredging	Construction	• The impact can be reduced by minimising the dredged area and the depth of dredging whilst still taking into consideration safe berthing of ships.
Increased surface run-off due to construction	Construction	• Reasonable footprint of infrastructure built, and paving installed, on site. • Install stormwater management infrastructure such as culverts, storm water diversion channels etc..

Reduced baseflow due to groundwater abstraction	Operation	• The groundwater abstraction from each water supply well should be managed to minimise the vertical drawdown of the groundwater level within each well. The aim is to prevent the zone of influence of the groundwater level drawdown cone from reaching the Bonny River, or any other existing water supply wells on neighbouring properties.
		• The sustainable yield of each of the water supply wells will be determined from aquifer test results. The aquifer tests should be done in compliance with international best practice guidelines and include at least:
		  ◦ Calibration / step test, which entail at least 3 x 1-hour steps on increasing yield followed by recovery at the end of the 3 steps. The groundwater level depth should be monitored at a regular interval, preferably with a continuously (30 second interval) measuring level logger.
		  ◦ A 24-hour constant rate test during which a constant volume of wate should be pumped from the well. The pumping rate will be determined from the calibration / step test phase. The groundwater level should be monitored at a regular interval, preferably with a continuously (30 second interval) measuring level logger.
		  ◦ Recovery of the groundwater level in the well should be measured after completion of the 24-hour

Issue	*Phase*	*Mitigation/Management Measures*
		constant rate pumping phase. The recovery of the groundwater level should be monitored until 90% recovery is reached, or 24 hours, whichever comes first. • A pumping schedule should be designed that aims to supply the required water volume, but also minimises the groundwater level drawdown in each of the wells. Preferably, the wells should not be pumped continuously for 24 hours per day, 7 days per week. Rather, a schedule should be developed where the groundwater level will be allowed to recover to natural, or near natural level, before pumping resumes. Allowing the groundwater level to recover in the well will minimise the extent of the drawdown cone, which in turn will minimise the possibility of salt water being drawn from the Bonny River towards the water supply wells and the resultant impact of saltwater intrusion on the aquifers. This schedule will be developed by a qualified hydrogeologist. • The water supply wells should be located as far as possible from the Bonny River, as well as other existing water supply wells on neighbouring properties, to reduce the possibility of saltwater intrusion from the Bonny River.
Increased vehicular movement potentially increasing the hydrocarbon load in the Bonny River	**Construction**	• The number of vehicles should be controlled travelling on site, ensuring maintenance is done at regular intervals, and within designed workshop areas which are bunded and equipped with adequately designed oil traps. • Install stormwater management infrastructure such as culverts, stormwater diversion channels etc
Spill of ammonia and urea products	**Operation**	• Where possible, (i.e., through the use of vessels with a larger carrying capacity) minimise the number of vessels. • Minimise the time that vessels spend at the berth. • Monitor waste or accidental spills.
Increased flood risk	**Construction** **Operation**	• Manage the earthworks to control surface slope. • The footprints for all infrastructure should (where possible) be restricted to the minimum feasible extent with measures implemented to roof and paved areas. • Install stormwater management infrastructure such a berms and culverts.

6.2.7.2 Monitoring Measures

Pre-construction and Construction Phases

- The area and depth of dredging will be monitored to ensure minimum disturbance of the river channel bed.
- Construction of the surface infrastructure will be monitored to ensure footprint areas that could increase surface runoff into the Bonny River are minimised. As built areas (location and size) will be recorded.
- Construction and maintenance of stormwater management infrastructure will be monitored to ensure optimal operation.
- Monitoring wells installed during the construction phase in the area between the water supply wells and the Bonny River will be used to monitor the groundwater quality for saltwater intrusion from the Bonny River.
- Monitor the number of vehicles and vehicular movement on site to limit soil erosion and hydrocarbons spills that could impact the river water quality during installation of the bored piles, construction of the surface infrastructure, and installation of the water supply wells.
- Storage of chemicals and hazardous materials in appropriately designed and managed containment areas or containers will be monitored.
- Monitor surface soil erosion that could increase the sediment load in the Bonny River during and after rainfall events.
- Record and control handling, storage and proper disposal of oil, cleaning fluids, used parts / spares, other contaminated materials such as rags, and chemicals that could impact the river water quality.
- Control adherence to proper cleanup procedures after accidental spills that could enter the Bonny River.

Operational Phase

- The area and depth of maintenance dredging will be monitored to ensure minimum disturbance of the river channel bed.
- Maintenance of stormwater management infrastructure will be monitored to ensure optimal operation.
- Monitoring wells installed during the construction phase in the area between the water supply wells and the Bonny River will be used to monitor the groundwater quality for saltwater intrusion from the Bonny River.
- Monitor the number of vehicles and vehicular movement on site to limit soil erosion and hydrocarbons spills that could impact the river water quality.
- Storage of chemicals and hazardous materials in appropriately designed and managed containment areas or containers will be monitored.

- Monitor surface soil erosion that could increase the sediment load in the Bonny River during and after rainfall events.
- Record and control handling, storage and proper disposal of oil, cleaning fluids, used parts / spares, other contaminated materials such as rags, and chemicals that could impact the river water quality.
- Control adherence to proper cleanup procedures after accidental spills that could enter the Bonny River.

6.3 Biological Environment

6.3.1 Terrestrial Environment

Table 6-7 presents mitigation measures for terrestrial biodiversity impacts for both construction and operation. The sources to the potential impacts include vegetation clearing and landscaping, dredging, excavation and clearing, chemical and hydrocarbon spills, littering and pollution, waste disposal and potential emissions from power generation.

6.3.1.1 Mitigation/Management Measures

Table 6-7: Mitigation/Management Measures for Terrestrial Biodiversity.

Issue	*Phase*	*Mitigation/Management Measures*
Terrestrial habitats and Flora • Direct destruction of modified habitats and their vegetation and potential loss of seed-storing topsoil • Potential for further spread or re-establishment of alien invasive species. • Potential for accelerated erosion • Reduced re-establishment potential of indigenous vegetation • Temporary smothering of plants with dust • Potential reduced resilience of remnant mangrove patches to persist.	**Construction**	• Biodiversity incident and observations should be recorded to monitor efficacy of mitigation measures and prevent possible aggravation of all potential impacts. Additionally, implementation reports linked to a GIS database to be established, and biodiversity material should be adequately incorporated in all induction training for all staff and site visitors. • Ensure biodiversity mitigation measures are incorporated and adequately cross-referenced in all relevant management policies. • In order to protect biodiversity, cleared and sealed surfaces need to be fitted with sufficient stormwater drainage systems, spillages of hazardous chemicals need to be contained with urgency, and adequate waste-disposal, plastic waste and wash-room facilities shall be provided in alignment with waste management and emergency response plan. • To mitigate the addition or continued re-establishment of alien invasive flora; a control plan must be drafted (complete with an identification guide of alien invasive plant and appropriate control measures that prevent

Issue	*Phase*	*Mitigation/Management Measures*
• Potential damage of terrestrial habitats and flora by unchecked pollution and uncontained spillages		regeneration), alien invasive plant routes of introduction must be identified, and surrounding communities must be encouraged to continue harvesting alien invasive plants that are suitable as firewood. • Avoid using topsoil from areas colonized by alien invasive species as this will encourage the propagation and spread of invasive flora. Only consider the use of such soils, if they will be deeply buried or sealed to ensure regenerative material contained in such soils are destroyed. • Revegetation of disturbed areas with a dense low grass layer should be prioritised to suppress alien invasive plant establishment. • For all landscaping/gardening of the Project site, only use indigenous flora. • To avoid siltation of rivers and/or accelerated erosion, soil stockpiles – anticipated to be temporary - should be located away from shorelines and drainages and surrounded by silt traps. • Design and create berms and/or stormwater management structures to prevent runoff from the construction areas during/after a periodic rainfall event to enter directly into rivers. • The permissible edge of any area to be cleared or worked on must be demarcated, and no movement of vehicles or machinery will be allowed outside this demarcation (especially for the remnant mangrove habitats and associated shorelines). • If feasible, cleared biomass should be processed at the clearing locality within 72 hours of clearing, and usage of different types of material (logs, branches, brush) predetermined to prevent cleared material smothering any habitat outside the Project footprint. • To reduce the loss of native biota and prevent the spread of invasive flora, open fires may only be permitted in designated secure areas.
Terrestrial habitats and Flora • Continued potential for further spread or re-	**Operation**	• Biodiversity incident and observations should be recorded to monitor efficacy of mitigation measures and prevent possible aggravation of all potential impacts. Additionally, implementation reports linked to

Issue	Phase	Mitigation/Management Measures
establishment of alien invasive species • Increased pollution and sedimentation potential from runoff coming from bare or sealed surfaces • Loss of water-cleaning capacities of degraded ecosystems around the Project site • Potential reduced resilience of remnant mangrove patches to persist • Potential damage of terrestrial habitats and flora by pollution		a GIS database must be established, and biodiversity material should be adequately incorporated in all induction training for all staff and site visitors. • Ensure biodiversity mitigation measures are incorporated and adequately cross-referenced in all relevant management policies. • Aligned to the waste-management and emergency response plan, cleared and sealed surfaces need to be fitted with sufficient stormwater drainage systems, spillages of hazardous chemicals need to be contained with urgency, and adequate waste-disposal, plastic waste and wash-room facilities shall be provided in order to protect biodiversity. • To mitigate the addition or continued re-establishment of alien invasive flora; a control plan should be drafted (complete with an identification guide of alien invasive plant and appropriate control measures that prevent regeneration), alien invasive plant routes of introduction must be identified, and surrounding communities must be encouraged to continue harvesting alien invasive plants that are suitable as firewood. • For all landscaping/gardening of the Project site, continue using indigenous flora. • Water, including runoff, potentially contaminated with hydrocarbons, ammonia, urea, nitrogen, or other potential pollutants should not be allowed to enter any stormwater drains (unless such are connected to a separator sump), rivers or drainages. • To reduce the loss of native biota and prevent the spread of invasive flora, open fires should not be permitted on site.
• Terrestrial fauna and avifauna • Displacement of fauna frequenting the Project site • Disturbance to fauna due to increased noise and light levels, as well as air pollution	**Construction**	• To avoid construction-related faunal mortality or injury, a faunal handling procedure should be drafted, all staff should be aware of the handling procedure and be aware of what to do in case of a faunal incident, fence or berm deep excavation, limit vehicle movement in Project area, and avoid working when there is limited light available.

Issue	Phase	Mitigation/Management Measures
• Mortality or injury to fauna due to construction-related activities • Potential mortality or injury of fauna by pollution		• Limit lighting levels and high noise-emitting operations to between sunrise and dusk as far as possible in order to reduce disturbance to fauna. • Lighting should be restricted to minimal motion-activated lighting only or avoided near the shoreline to reduce disturbance levels to fauna. • Monitor permanent structures that may be attractive to especially avifauna to roost, perch or even breed on, or may be of low visibility to avifauna and ensure: • All electrically live components are duly insulated. • Perch deterrents are fitted and maintained on all structures where fauna could become injured, e.g., on or close to the flare stack, wooden beams underneath roofs close to loading and unloading facilities or electrical installations. • Record all faunal incidents and encourage reporting of any faunal sightings on or in close proximity to the Project site. • No open fires may be lit for any purpose on the site.
• Terrestrial fauna and avifauna • Disruption of breeding and other activities due to increased noise and light levels • Faunal illness and reproductive loss due to air pollution • Mortality or injury to fauna due to vehicle/ machinery movement, entrapment or electrocution • Mortality or injury to fauna due to inadequate waste management, with an emphasis on organic and plastic waste • Mortality of fauna due to exposure to ammonia	• **Operation**	• Avoid construction-related faunal mortality or injury by applying and continually updating the faunal handling procedure, and ensure all staff are aware of these procedures and know whom to approach and what to do in case of a faunal incident. • Limit lighting levels and high noise-emitting operations to between sunrise and dusk as far as possible in order to reduce disturbance to fauna. • Lighting should be restricted to minimal motion-activated lighting only or avoided near the shoreline. • No open fires may be lit for any purpose on the site. • Continue to record all faunal incidents and encourage reporting of any faunal sightings on or in close proximity to the Project site. • Continue to monitor permanent structures that may be attractive to especially avifauna to roost, perch or even breed on, or may be of low visibility to avifauna and ensure: • All electrically live components are duly insulated. • Perch deterrents are fitted and maintained on all structures where fauna could become injured, e.g., on

Issue	Phase	Mitigation/Management Measures
• Displacement of fauna due to loss of habitat and ongoing disturbances		or close to the flare stack, wooden beams underneath roofs close to loading and unloading facilities or electrical installations. • No open fires may be lit for any purpose on the site.

6.3.1.2 Monitoring Measures for Construction and Operational Phase

- Aligned to the waste-management- and air quality plans, continually monitor emission levels, dust levels and areas prone to chemical and hydrocarbon spills to enable timeous mitigations.
- Inspect all bare areas on and adjacent to the Project footprint for signs of accelerated erosion, especially after high rainfall events to allow immediate mitigation to limit damage.
- Monitor all disturbed areas and potential temporary stockpiles of topsoil and/or subsoil for the emergence of undesirable alien invasive plants and eradicate immediately to prevent production of regenerative material.
- A Biodiversity Management Plan (BMP), including a Biodiversity Monitoring Program, must be drafted at the latest by the time the pre-construction has been completed, and be revised every 5 years. The same monitoring measures are recommended during the operational phase of the Project.
  - The BMP will need to also include faunal monitoring, especially where species choose to roost or otherwise 'more permanently use' the Project site to ensure the compatibility of such with Project operations, prioritising the safety of indigenous fauna.
- All revisions to the BMP need to take all incident registers during the preceding 5 years into account, with emphasis to any unforeseen event that may have occurred, ensuring biodiversity management keeps on being fully aligned to all existing and potential challenges and/or threats of Project operations to local biodiversity.

6.3.1.3 Mitigation/Management Measures for Unplanned Events

- The BMP should have a full set of monitoring requirements and methods specified for at least flooding, all types of spillages, flaring, storms, and 'general' unplanned events.
- After every unplanned event, evaluate how effective existing mitigation and emergency response management measures were, what could not be mitigated and extent and damage of residual impacts, and then update the BMP and all related actions in other management plans to improve mitigation for the potential next unplanned event.
  - The above needs to emphasize early warning systems, shut-down actions, and containment; and

- Ensure mitigation and management for biodiversity in unplanned events is aligned to or can potentially feed into the general management of the Bonny River Channel.

6.3.2 Marine and Aquatic Environment

6.3.2.1 Mitigation/Management Measures for Planned Events

This Section (and more specifically Table 6-8 provides high-level mitigation/management measures for the Project to consider in planning for both construction and operation.

Table 6-8 Mitigation and Management Measures for Marine and Aquatic Impacts.

Issue	*Phase*	*Mitigation/Management Measures*

Direct loss of estuarine habitat and biota within the development footprint	**Construction**	• Inform all staff about sensitive estuarine habitats and species.
		• Constrain spatial extent of impacts to the minimum required.
		• Keep construction equipment within the developmental footprint, and do not disturb sediment outside this area.
		• A rigorous environmental management and control plan should be developed and implemented.
		• A suitable biodiversity offset strategy that meets the requirements of PS6 should be developed by qualified personnel. This offset strategy should be developed in partnership with local NGO's active in preserving mangrove systems in the broader Project area and could include:
		  ○ Expansion of existing protected mangrove systems.
		  ○ Improved management or habitat enhancement of existing protected mangrove systems.
		  ○ Financial support to existing mangrove conservation funds.

Impacts of dredging and associated impacts on avifauna	**Construction**	• Dredging methods that resuspend the least quantity of fine-grained sediment into the water column should be used. • The dredging footprint should be restricted to the smallest area and depth possible (i.e., do not over dredge) to minimise the quantity and period during which sediment is resuspended into the water column. • There should be no overflow or leakage from hopper and barge compartments during non-dredging transit at the dredging site and during transit to the dredged spoil disposal site. • Hoppers and barges should not be overfilled. • Continuous monitoring should be undertaken of turbidity levels during the dredge operations. Data from the turbidity

Issue	*Phase*	*Mitigation/Management Measures*
		monitoring instruments should be available in real time to the person coordinating dredging activities. • The time period over which the dredging operation is to take place should be minimised, to avoid the daily re-suspension of sediments. • Use of silt curtains during dredging is recommended to contain the extent of the turbidity plume as much as possible.
Disturbance to avifauna	**Construction**	• Limit duration of construction activities near the estuary as far as practically possible. • Efforts should be taken to reduce unnecessary noise or vibrations where possible. • Loud construction activities, including large vehicle traffic, to be restricted to times outside of peak waterbird feeding time – i.e., at least an hour away from dawn and dusk. • Where possible, it is recommended that no construction activities should be permitted between sunset and sunrise. • Construction should be timed so that the loudest period does not coincide with the main migratory bird season (dry season). • Where possible, contractors are to deploy “soft starts” to ensure fauna leave the immediate area prior to the commencement of very loud activities. • Mobile equipment, vehicles and power generation equipment should be subjected to noise tests which are measured against manufacturer specifications to confirm compliance before deployment on site as a precautionary measure. Noise emissions from mobile and fixed equipment should be subject to periodic checks as part of regular maintenance programmes to allow for detection of any unacceptable increases in noise. • Minimise the duration of construction-related noise as far as practically possible. • Constrain spatial extent of impacts to the minimum required. • Keep construction equipment within the developmental footprint. • Inform all staff about sensitive estuarine habitats and species.
Light pollution	**Construction** **Operation**	• Before construction, a light-at-night survey should be undertaken to determine the baseline illumination levels in estuarine habitats near the development site, such that future monitoring has a reference point.

Issue	Phase	Mitigation/Management Measures
		• Only add light for specific purposes. Remove excess/unnecessary lights and turn off lights in areas not in use. • Restrict uplighting and water illumination. • Use adaptive light controls to manage light timing, intensity and colour. • Light only the object or area intended – keep lights close to the ground, directed, and shielded to avoid light spill. • Use the lowest intensity lighting appropriate for the task. • Use non-reflective, dark-coloured surfaces. • Use lights with reduced or filtered blue, violet, and ultra-violet wavelengths. Avoid high intensity light of any colour. • Implement actions when birds are likely to be present. This includes peak migration periods and the Nigerian dry season. • No light source should be directly visible from foraging or nocturnal roost habitats, or from migratory pathways. • Install screening/shielding with appropriate materials along the sides of the vessels. • Do not install fixed light sources in nocturnal foraging or roost areas. • Use curfews to manage lighting near nocturnal foraging and roosting areas. For example, manage artificial lights using motion sensors and timers from sunset until dawn. • Use flashing/intermittent lights instead of fixed beam. • Use motion sensors to turn lights on only when needed. • Reduce deck lighting to minimum required for human safety on vessels moored near nocturnal foraging and roost areas. • Prevent indoor lighting reaching migratory waterbird habitat, by using blinds, curtains, or shutters. • In facilities requiring intermittent night inspections, turn lights on only during the time operators are moving around the facility. • Use appropriate wavelength, explosion proof LEDs with smart lighting controls and/or motions sensors. LEDs have no warmup or cool down limitations so can remain off until needed and provide instant light when required for routine nightly inspections or in the event of an emergency. • Industrial site/plant operators to use personal torches.

Issue	*Phase*	*Mitigation/Management Measures*
Increased underwater noise	**Construction**	• Enforce a maximum speed limit for vessels travelling along the estuary to the Project site. • Use noise minimizing procedures during piling, such as bubble curtains. • Where possible, employ construction methods that generate less noise.
	Operation	• Employ a soft start when pile driving. • Spotters should be employed to watch for aquatic mammals during underwater construction activities. If any aquatic mammals are sighted, construction should pause until they have left the area. • Vessels must maintain a buffer of at least 200 m from waterbirds.
Changes in stormwater runoff	**Construction**	• Aligned to the water-management plan, ensure monitoring of the quality of runoff and other water discharged to the environment. Also monitor the quality of groundwater and surface water in close proximity to the Project site, incorporating aquatic indicators (see *Section* 5.7.2). Construction plans must ensure erosion control, sediment retention, and good housekeeping on the construction site. • Safely dispose of excess sediment. • Avoid construction, especially earth moving, during the rainy season. • Implementation of erosion control measures such as silt fences in areas at risk of erosion/runoff. • Should sand piles be left for long periods of times they should be secured with geotextile material to prevent wind mobilization into the estuary. • Monitor construction areas post rainfall events and repair any erosion damage that may have occurred.
Changes in estuarine form and function	**Construction**	• No mitigation required.
Routine discharges from vessels	**Operation**	• Ballast water should be treated appropriately before discharge. • Sewage should be treated appropriately before discharge.

6.3.2.2 Monitoring Measures

- Baseline, pre-construction surveys for underwater noise levels and levels of light at night should be undertaken to provide a baseline against which future changes and impacts can be bench marked.
- Monitoring should be undertaken to confirm the implementation of mitigation measures, particularly with regards to dredging, underwater noise, and artificial light at night.
- Before construction commences, a waterbird survey during December/January (when the birds are likely to be present in the Project area) needs to be undertaken. It is during this period that waterbirds travel south from their northern hemisphere breeding grounds to their southern hemisphere feeding grounds. Once construction has commenced, monthly surveys should be undertaken to monitor for changes in waterbird communities in the vicinity of the Project, following a before-after-control-impact (BACI) approach. If an effect if observed, adaptive management informed by monitoring results must be implemented.
- Marine Mammal Observers should be employed during loud noise-producing underwater construction activities such as pile driving. Should marine mammals be sighted, underwater construction should be paused until the mammals have left the area.

6.3.2.3 Mitigation/Management Measures for Unplanned Events

This Section (and more specifically Table 6-9) provides high-level mitigation/management measures for unplanned events.

Table 6-9 Mitigation and Monitoring Measures for Marine and Aquatic Impacts arising from Unplanned Events.

Issue	*Phase*	*Mitigation/Management Measures*
• Spills of ammonia-derived products	Operation	• A Spill Prevention and Management Plan must be compiled and implemented. In the event of any significant spill the port authorities must be notified, and cleanup should commence as quickly as possible. • Comprehensive safety checks frequently undertaken of all project components and processes. • Frequent risk assessments and adaptive management where required. • Good housekeeping to be done. • Intentional disposal of any substance into the environment is strictly prohibited, while accidental spillage must be prevented, contained, and reported immediately.

Issue	Phase	Mitigation/Management Measures
		• All hazardous substances should be accompanied by a Material Safety Data Sheet (MSDS) and may only be handled by suitably trained operators. • Spill kits should always be available on site, and staff must be trained in their proposed use.
• Catastrophic loss of containment	Operation	• An emergency plan must be compiled and implemented. • Comprehensive safety checks frequently undertaken of all Project components and processes. • Frequent risk assessments and adaptive management where required. • Good housekeeping to be maintained.
• Fuel spills and other pollution	Construction	• Construction workers and operational staff to adopt best practice waste minimization procedures. • Implement the correct handling and disposal procedures for general and hazardous waste. • Intentional disposal of any substance into the environment is strictly prohibited, while accidental spillage must be prevented, contained, and reported immediately. • All fuel and oil must be stored with adequate spill protection. • All hazardous substances should be accompanied by MSDS and may only be handled by suitably trained operators. • Spill kits should be available on site at all times, and staff should be trained in their proposed use. • Reduce the amount of waste generated from the construction phase by means of efficient operations and recycling of general waste. • The establishment and operation of the development site should follow a stringent Environmental Management Programme that is monitored. • Sufficient ablution facilities should be provided for construction personnel and sited away from high-risk areas. These must be frequently cleared. • The Project area should be adequately protected against adverse weather conditions, particularly the chemical storage areas, to prevent erosion and run-off of contaminants into the estuary.

Issue	Phase	Mitigation/Management Measures
		• Strict adherence to pollution, emergency, and health and safety protocols, and other applicable maritime legislation and policies. • A Spill Prevention and Management Plan should be compiled and implemented. In the event of any significant spill the port authorities must be notified, and cleanup should happen as quickly as possible. • A method statement in respect to the use, handling, storage, and disposal of all chemicals as well as anticipated generated waste, should be compiled and submitted as part of any Environmental Management Programme. • Correct handling, storage and disposal procedures should be followed (e.g., bunded storage areas to contain 110% of volume). • Maintain vehicles and equipment - no leaking vehicles or equipment to be permitted on site. All vehicles and machinery should be parked or stored on an impervious surface. • A comprehensive environmental awareness programme should be conducted amongst contracted construction personnel about sensitive estuarine and marine habitats and the need for careful handling and management of chemical substances, and correct disposal of all waste.

6.4 Socio-Economic Environment

This Section presents mitigation measures for anticipated socio-economic impacts.

6.4.1 Mitigation of Socio-economic Impacts During Pre-Construction

Pre-construction activities are associated with socio-economic issues such as disruption of local livelihoods and un-met expectations.

Table 6-10 presents proposed mitigation measures to minimise impacts during the pre-construction phase.

6.4.1.1 Mitigation/Management Measures During Pre-Construction

Table 6-10: Mitigation/Management Measures for Socio-economic Impacts during Pre-Construction.

Issue	*Mitigation/Management Measures*
Disruption to local subsistence livelihoods – specifically fishing.	MM FZE should design security policies in line with the Voluntary Principles on Security and Human Rights (VPSHR). Local contractors used to carry out security-related services should be compliant with the VPSHR.
	• MM FZE should incorporate into the Stakeholder Engagement Plan (SEP) proactive engagements with local communities potentially impacted by pre-construction activities within or adjacent to fishing waters. The MM FZE should seek to transparently communicate these impacts, and should the impact be found to be significant, supported affected stakeholders through identification of new fishing areas
Unmet expectations of benefits	• MM FZE should ensure that the increased socio-economic benefits derived to communities are commiserate during various project activities. • MM FZE should ensure transparent and continued communication with all stakeholders to ensure that community expectations are aligned to what the Project can realistically deliver. This must include the update of the SEP to include activities related to the Project, as well as continuous oversight to ensure the timely and effective implementation of this plan. • MM FZE must ensure that an updated Incident and Grievance procedure is in place and that it covers the new activities undertaken in relation to the project.

6.4.2 Community Health and Safety

This Section provides high-level mitigation/management measures for community health and safety during the construction and operations phases (Table 6-12).

6.4.2.1 Mitigation/Management Measures for Planned Events

Table 6-11: Mitigation/Management Measures for Community Health and Safety Impacts.

Issue	***Phase***	***Mitigation/Management Measures***
Community Health and Safety	**Construction**	• MM FZE should maximise the use of a local workforce, to minimise the health and safety risks related to interactions between local populations and a large contractor workforce. • Where contractors are unavoidable, MM FZE should consider providing temporary facilities for primary healthcare services to avoid overwhelming of local healthcare facilities. • The incident and grievance management process should be updated to appropriately accommodate grievances related to sexual assault or abuse by contractors, or gender-based harm as a result of Project activities. • MM FZE should design and implement workplace policies in line with IFC guidelines, and ensure that contractors do likewise, to prevent gender-based violence and sexual abuse of local communities. • A traffic management plan should be implemented for the construction and operational phases. The Construction contractor's compliance with this plan should be monitored. The plan should ensure that appropriate measures are put in place to reduce the risk of injuries or fatalities of pedestrians, as well as vehicle accidents with other road users. • All reasonable measures should be taken, during construction, to minimise community exposure to noise, dust, and vibrations. • MM FZE should design security policies in line with the Voluntary Principles on Security and Human Rights (VPSHR). Local contractors used to carry out security-related services should be compliant with the VPSHR.

6.4.3 Community Stability and Livelihoods

This Section provides high-level mitigation/management measures for community stability and livelihoods during the construction and operations phases (*Table 6-12*).

6.4.3.1 Mitigation/Management Measures for Planned Events

Table 6-12: Mitigation/Management Measures for Community Stability and Livelihoods.

Issue	*Phase*	*Mitigation/Management Measures*
Community Stability and Livelihoods	**Construction** **Operation**	• MM FZE should seek to recruit locally, in so far as possible, to minimise reliance on migrant labourers. Given the long-term operational life of the Project, MM FZE should investigate the possibility of using vocational training in local communities to close skills-gaps and further reduce reliance on migrant labour for future skills requirements. • MM FZE should actively engage with local authorities to understand the infrastructure and service delivery challenges associated with influx and identify means by which MM FZE can partner with authorities to address these. Where possible and appropriate, MM FZE should further engage local authorities on regional growth and development plans, and how MM FZE may contribute to these. • MM FZE may consider enterprise and supplier development initiatives which enhance the capacity of local businesses to supply both the Project and other industries within the AoI. Leveraging local suppliers and reducing reliance on external procurement will enhance the ability of the local economy to absorb job seekers. • MM FZE should incorporate into the SEP proactive engagements with local communities potentially impacted by construction activities within or adjacent to fishing waters. MM FZE should seek to transparently communicate these impacts, and should the impact be found to be significant, supported affected stakeholders through identification of new fishing areas. • MM FZE should ensure that the increased socio-economic benefits derived to communities are commiserate with the expansion of Indorama's existing operations. • MM FZE should ensure transparent and continued communication with all stakeholders to ensure that community expectations are aligned to what the Project can realistically deliver. This should include the update of the SEP to include activities related to the Project, as well as continuous oversight to ensure the timely and effective implementation of this plan. • MM FZE should ensure that an updated Incident and Grievance procedure is in place and that it covers the new activities undertaken in relation to the project.

6.4.4 Labour and Working Conditions

This Section provides high-level mitigation/management measures associated with labour and working conditions (Table 6-13*)* during the construction and operations period.

6.4.4.1 Mitigation/Management Measures for Planned Events

Table 6-13: Mitigation/Management Measures for Planned Events.

Issue	*Phase*	*Mitigation/Management Measures*
Labour and Working conditions	Construction Operation	• MM FZE's recruitment policies, standards, and procedures should be transparently communicated to host communities to ensure equal and fair access to employment opportunities, especially for vulnerable groups. • MM FZE should design and implement workplace policies in line with IFC guidelines, and ensure that contractors do likewise, to promote working conditions which ensure worker safety and a respect for human rights. Where such policies have already been designed, MM FZE should ensure implementation, as well as ongoing monitoring and evaluation of such policies. Particular attention should be given to designing social monitoring and evaluation procedures for contractors. • MM FZE must ensure that all permanent and contractor workers, including those employed by Construction contractors, have access to the employee grievance mechanism, ensuring that allegations of poor or unsafe working conditions or human rights violations can be appropriately investigated.

6.4.5 Mitigation Measures for Unplanned Events

6.4.5.1 Mitigation/Management Measures for Unplanned Events.

Based on the livelihoods impacts considered in *Section 5.3*, a potential unplanned contamination of fishing waters surrounding the Project site by pollutants such as diesel or cement during the construction phase, or urea or ammonia during the operational phase, may impact the viability of fishing waters used by local communities

Local communities engaging in fishing livelihoods are likely economically vulnerable; as such, any significant impacts to their ability to sustain their livelihoods will result in a moderate level of vulnerability.

Key mitigation in the event of unplanned contamination include:

- Ensure immediate notification of both local authorities and business forums or community groups related to fishing of:
  - The spill and potential for contamination of aquatic species.

- Instruction to cease collection of aquatic species for commercial or subsistence use.
- Clean up protocols in place and timeframes.

- Should the contamination be significant (i.e., resulting is fish kills within the water of port Onne adjacent), then compensation for loss of livelihoods should be allocated. To ensure this compensation not misused, it is preferable that the most vulnerable groups are considered as priority, and depending on the extent of the impacts, commercial groups should be considered second. Where possible, this should be non-monetary compensation for the loss of livelihoods or negotiated through the relevant and legitimate organisations to ensure fair and equitable distribution.

6.4.6 Traffic

This Section provides mitigation/management measures for traffic during the construction and operations phases (Table 6-14).

6.4.6.1 Mitigation/Management Measures for Planned Events

Table 6-14: Mitigation/Management Measures for Traffic.

Issue	*Phase*	*Mitigation/Management Measures*
Road infrastructure maintenance	Construction Operation	• Require Project drivers to report observed instances of road degradation. • Work with appropriate authorities to encourage maintenance of public roads near the Indorama Complex
Reduction of access to transport	Construction	• Consider scheduling vehicular movement during observed off-peak periods. This would be preferably during weekends (Sundays) as the survey has shown that there is relatively light traffic on that day
Vehicle Cleaning and Loading	Construction Operation	• Use water trucks to reduce dust that would be carried onto the public roads by haul trucks and other vehicles, especially during construction. • Securely cover loads on trucks to minimize spillage and dust. • Do not overload trucks.
Enhanced Safety through Driver Qualification Standards and Training, both	Construction Operation	• Use only drivers with the required driving license. Enforce driver qualifications and training for all drivers, whether employees or sub-contractors. Include requirements in applicable contracts.

Issue	*Phase*	*Mitigation/Management Measures*
General and Project-specific		• Establish driver training program specific to the vehicles, roads and risks encountered for the particular tasks. • Require regular truck driver safety training, defensive driving training, and testing.
Traffic Management for Improved Safety and Reduced Road Congestion	**Construction** **Operation**	• Communicate with authorities including the NPA and affected communities (including port users, emergency services, and public transport providers) about lane closures and diversions. • Establish and enforce speed limits within construction areas and along delivery routes during operations. • Use signs (reflective signs and/or flashing lights for night), traffic cones, and positioning of flag persons to direct traffic as necessary.
Prevention of Nuisance and Visibility Hazard from Airborne Dust or Dirt on Roads	**Construction**	• Wash all trucks leaving the Project site using a dedicated wash station where water can be continually recycled.
Vessel Traffic Safety	**Operation**	• Observe standard international and local navigation procedures in and around Onne Port, as well as best ship-keeping and navigation practices while at sea. • Require vessels associated with the Project to be equipped with (and to operate) navigation aids, lighting, communications equipment, and radar equipment, consistent with international maritime standards.
Enhanced Safety through Stakeholder Engagement and Education	**Pre-Construction and Construction** **Operation**	• Maintain (or initiate, where needed) relationships with local stakeholders and port users to understand risks particular to the daily traffic patterns and schedules, or when port activities would result in high road use. • Provide the Nigeria Ports Authority (NPA) with construction schedule road usage during operations. • Provide a grievance mechanism that is easy to access, transparent, and responsive. Accept grievances related to MM FZE road traffic in writing, electronically, by telephone, or verbally at community stakeholder meetings. Create written record of all grievances submitted verbally.

Issue	***Phase***	***Mitigation/Management Measures***
Driver behaviour	**Construction** **Operation**	• Establish and enforce rest and break standards that comply with industry and national standards. • Structure contracts with truck contractors to avoid incentives for speeding or insufficient fatigue breaks. • To the degree permissible by law, require daily or periodic drug and alcohol testing for all drivers. • Equip trucks with speed governors and on-board GPS to monitor vehicle speed and location. • To the extent agreed by law, enforce driver quality through loss of jobs or contracts for individual drivers for drug or alcohol offenses and chronic or egregious speeding

6.4.7 Cultural Heritage

This Section provides mitigation/management measures for cultural heritage impacts during the construction phase (Table 6-15).

Table 6-15: Mitigation/Management Measures for Cultural Heritage.

Issue	*Phase*	*Mitigation/Management Measures*
Management of Chance Find	**Construction**	• Ensure that a robust Chance Find Procedure (CFP) is developed prior to construction and used throughout the life cycle of the Project. The CFP will be used to manage any unexpected discovery of archaeological material in-line with international requirements and guidelines IFC PS8
Awareness creation	**Construction**	• Training and Awareness for cultural heritage and implementation of CFP • The project workforce will be trained on the recognition of sites with historical or cultural value and the actions to be taken in the event of any sites or finds being encountered.

Moreover, the following is recommended:

- Ensure verifiable tracking of all Cultural Heritage finds from discovery through development and implementation of treatment plans.
- Monitoring should be undertaken to make sure all cultural heritage finds are recorded and documented.
- Ensure periodic auditing of all training records for contractors and company staff on cultural awareness.

Table 6-16: Summary of Physical, Biophysical and Socio-economic Environmental Impacts pre and post mitigation

Impact	Significance (Pre-mitigation)	Significance (Post-mitigation)
Physical Environment Impacts		
Impacts related to construction dust	Minor Negative Impact	Negligible Impact
Impacts related to construction traffic air quality	Negligible Impact	Negligible Impact
Impacts related to operational traffic on air quality	Negligible Impact	Negligible Impact
Impacts related to operation of the port air quality	Negligible Impact	Negligible Impact
Impacts related to bored piles installation on the geology	Minor Negative Impact	Minor Negative Impact
Impacts related to surface infrastructure installation on the geology	Minor Negative Impact	Minor Negative Impact
Impacts related to dredging on the geology during the construction	Minor Negative Impact	Minor Negative Impact
Impacts related to water supply wells installation on the geology	Minor Negative Impact	Minor Negative Impact
Impacts related to dredging on the geology during the operational	Minor Negative Impact	Minor Negative Impact
Impacts related to bored piles installation on the soils	Minor Negative Impact	Minor Negative Impact
Impacts related to surface infrastructure installation on the soils	Moderate Negative Impact	Moderate Negative Impact
Impacts related to water supply wells installation on the soils	Minor Negative Impact	Minor Negative Impact
Impacts related to vehicular use on the soils during the construction	Minor Negative Impact	Minor Negative Impact
Impacts related to vehicular use on the soils during the operational	Minor Negative Impact	Minor Negative Impact
Impacts related to saltwater intrusion on the groundwater	**Major Negative Impact**	Moderate Negative Impact
Impacts related to bored pile installation on the groundwater	Minor Negative Impact	Negligible Negative Impact
Impacts related to chemical and hydrocarbon spills on the groundwater	Moderate Negative Impact	Moderate Negative Impact
Impacts related to saltwater intrusion on the groundwater	**Major Negative Impact**	Moderate Negative Impact
Impacts related to transport, loading and storage of urea on the groundwater during operation	Moderate Negative Impact	Moderate Negative Impact
Impacts related to transport, loading and storage of ammonia on the groundwater during the operation	Moderate Negative Impact	Moderate Negative Impact
Impacts related to using seawater as fire water on the groundwater	Minor Negative Impact	Minor Negative Impact

Impact	Significance (Pre-mitigation)	Significance (Post-mitigation)
Impacts related to sewage on the groundwater during the operation	Minor Negative Impact	Minor Negative Impact
Impacts related to dredging on the surface water during the construction	Minor Negative Impact	Minor Negative Impact
Impacts related to construction of surface infrastructure on the surface water	Minor Negative Impact	Minor Negative Impact
Impacts related to the water supply wells on the surface water during the construction	Minor Negative Impact	Minor Negative Impact
Impacts related to flood risk on the surface water during the construction	Negligible Negative Impact	Negligible Negative Impact
Impacts related to dredging on the surface water resource during the operation	Minor Negative Impact	Minor Negative Impact
Impacts related to marine vessels on the surface water during the operation	Minor Negative Impact	Minor Negative Impact
Impacts related to the groundwater abstraction on the surface water	Minor Negative Impact	Minor Negative Impact
Impacts related to vehicular use on the surface water during the operation	Minor Negative Impact	Minor Negative Impact
Impacts related to flood risk on the surface water resource during the operation	Negligible Negative Impact	Negligible Negative Impact
Biophysical Environment Impacts		
Pre-construction and construction impacts on indigenous flora and terrestrial habitats	Moderate Negative Impact	Minor Negative Impact
Pre-construction and construction impacts on indigenous terrestrial fauna and avifauna	Moderate Negative Impact	Minor Negative Impact
Operational Impacts on indigenous flora and terrestrial habitats	Moderate Negative Impact	Negligible Negative Impact
Operational Impacts on indigenous terrestrial fauna and avifauna	Moderate Negative Impact	Minor Negative Impact
Unforeseen impacts on terrestrial biodiversity	**Major Negative Impact**	Moderate Negative Impact
Impacts related to the direct loss of estuarine habitat and biota during construction	Minor Negative Impact	Negligible Negative Impact
Impacts related to dredging on the estuarine habitat and biota during construction	Minor Negative Impact	Negligible Negative Impact
Impacts related to general construction disturbance to avifauna	Moderate Negative Impact	Minor Negative Impact
Impacts related to dredging disturbance to avifauna during construction	Moderate Negative Impact	Minor Negative Impact
Impacts related to underwater construction noise on estuarine biota other than marine mammals	Minor Negative Impact	Minor Negative Impact
Impacts related to underwater construction noise on estuarine mammals	**Major Negative Impact**	Moderate Negative Impact

Impact	Significance (Pre-mitigation)	Significance (Post-mitigation)
Impacts related to changes in estuarine form and function	Negligible Negative Impact	Minor Negative Impact
Impacts related to changes in stormwater runoff due to construction	Minor Negative Impact	Minor Negative Impact
Impacts related to artificial light at night on estuarine biota on avifauna during operation	Moderate Negative Impact	Minor Negative Impact
Impacts related to operation underwater noise on estuarine biota other than mammals	Moderate Negative Impact	Minor Negative Impact
Impacts related to operational underwater noise on estuarine mammals	Moderate Negative Impact	Moderate Negative Impact
Impacts related to routine discharges from vessels	Minor Negative Impact	Moderate Negative Impact
Unplanned events related to fuel spills and other pollution	**Major Negative Impact**	Moderate Negative Impact
Impacts unplanned events related to spills of ammonia-derived products	**Major Negative Impact**	Moderate Negative Impact
Impacts related to catastrophic loss of containment	**Major Negative Impact**	Moderate Negative Impact
Socio-economic Impacts		
Impacts related to the economy and employment	Positive Impact	Positive Impact
Impacts related to road safety risks	**Major Negative Impact**	Moderate Negative Impact
Impacts related to communicable diseases, environmental health, and reduced access to healthcare facilities	Moderate Negative Impact	Minor Negative Impact
Impacts related to crime, conflict, security, and human rights	Moderate Negative Impact	Minor Negative Impact
Impacts related to the presence of a workforce and pressures on social resources	Moderate Negative Impact	Minor Negative Impact
Impacts related to the disruption of local subsistence livelihoods	Minor Negative Impact	Negligible Negative Impact
Impacts related to unmet expectations of benefits	Moderate Negative Impact	Minor Negative Impact
Impacts related to labour, working conditions, and unfair recruitment practices	Moderate Negative Impact	Minor Negative Impact
Impacts related to unplanned contamination of local fishing waters	Moderate Negative Impact	Minor Negative Impact
Impacts related to traffic operations during construction	Minor Negative Impact	Minor Negative Impact
Impacts related to traffic infrastructure during operational phase	Minor Negative Impact	Minor Negative Impact
Impacts related to traffic safety during construction phase	Minor Negative Impact	Minor Negative Impact
Impacts related to traffic operations during operational phase	Moderate Negative Impact	Minor Negative Impact

Impact	Significance (Pre-mitigation)	Significance (Post-mitigation)
Impacts related to traffic infrastructure during operational phase	Moderate Negative Impact	Minor Negative Impact
Impacts related to traffic safety during operational phase	Moderate Negative Impact	Minor Negative Impact

CHAPTER – SEVEN

ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MONITORING PLAN

7.0 ENVIRONMENTAL AND SOCIAL MANAGEMENT AND MONITORING PLAN (ESMMP)

The ESMMP is a wholistic and comprehensive management tool and define the guidelines, strategies, and procedures for managing the significant, possible, potential, and associated environmental and social impacts of the proposed project. The identified key environmental and socio-economic aspects and mitigation measures associated with the project are the basis for the ESMMP. The plan has been defined in accordance with the analyses carried out in the previous chapters of this Environmental and Social Impact Assessment report (ESIA).

The ESMMP is aimed at:

- Providing an initial analysis for the subsequent adoption of an Environmental and Social Management System (ESMS) in accordance with the National Regulations and International Guidelines.
- Identifying priorities of the actions needed to implement mitigation measures necessary to manage the impact and risks identified in the assessment on physical, biophysical, and socio-economic environment.

The ESMMP appended as **Appendix A** of this ESIA report, provides the vehicle for the integrated management of the potential impacts identified in the ESIA (both positive and negative). The ESMS provides a mechanism for ensuring that mitigation measures identified in the ESIA and associated ESMMP are adequately implemented resulting in enhanced sustainability of the project as well as sustaining the environment. Moreover, the ESMS provides a framework for monitoring, compliance auditing and inspection programmes, which assist the Project in meeting its commitments, as stipulated in Nigerian regulations and lender standards.

A detailed environmental and social monitoring plan to evaluate and monitor effectiveness of the ESMS is presented in Table 7-1, which will be implemented during construction and operation of the proposed project.

Table 7-1: Environmental and Social Monitoring Plan

S/N	Environmental Components	Indicator Parameters	Frequency	Location	Responsibility	Time Frame
1	Noise (Project site)	Sound Pressure	Weekly during Construction Monthly during Operation	Project Site & Environs	MM FZE– EHS Lead	Construction. Operations and Decommissioning
2	Waste management	Generated waste (quantity)	Regular evacuation schedule	Project Site	MM FZE – EHS Lead	Construction. Operations and Decommissioning
3	Ambient Air / Noise (6 Nos)	PM2.5 and 10; NOx, CO, O_3, VOC, SOx, CxHy, PM_{10}, $PM_{2.5}$	Monthly both during Construction & operation	Project Site & Environs	Third Party (Environment Consultant); Quarterly report to Regulators (FMEnv, RSMEnv, NPA)	Construction. Operations; and Decommissioning
4	Surface Water (12 Nos)	pH, Alkalinity, TSS, Conductivity, TDS, Ammonia, Turbidity, DO, COD, BOD, PO4, Metals etc.	Monthly both during construction work and quarterly during operation	Bonny Channel	Third Party (Environment Consultant); Quarterly report to Regulators (FMEnv, RSMEnv, NPA)	Construction. Operations; and Decommissioning
5	Sediments (12 Nos)	pH, Conductivity, Salinity, PO4, SO4, NO3, TOC, THC, Metals etc.	Quarterly both during construction work and operation	Bonny Channel	Third Party (Environment Consultant); Quarterly report to Regulators (FMEnv, RSMEnv, NPA)	Construction. Operations; and Decommissioning
6	Ground Water (6 Nos)	pH, Alkalinity, TSS, Conductivity, TDS, Ammonia, Turbidity, DO, COD, BOD, PO4, Metals etc.	Monthly both during construction work and quarterly during operation	Project Site & Environs	Third Party (Environment Consultant); Quarterly report to Regulators (FMEnv, RSMEnv, NPA)	Construction. Operations; and Decommissioning

S/N	Environmental Components	Indicator Parameters	Frequency	Location	Responsibility	Time Frame
7	Surface run-off (1No)	pH, Conductivity, Salinity, PO4, SO4, NO3, O&G, Metals etc.	Monthly both during construction work and operation	Project Site	Third Party (Environment Consultant); Quarterly report to Regulators (FMEnv, RSMEnv, NPA)	Construction. Operations; and Decommissioning
8	Biodiversity	Alien Species, Water bird survey and Lux level in Night hours	Quarterly during construction work	Project Site	Third Party (Environment Consultant);	Construction
9	OHS, Traffic & Socio-economic	OHS & Health statistics, Traffic data, Grievances, and other Social & worker's condition related indices	Monthly, Quarterly & Annual as applicable	Project Site & Environs	Third Party (Environment Consultant); Quarterly report to Regulators (FMEnv, RSMEnv, NPA)	Construction. Operations; and Decommissioning
10	Environmental Audit (EAu)	Various physical, biological & Socio-economic components as per Approved ToR	Every three years after operation start	Project Site & Environs	Third Party (Environment Consultant); Report to FMEnv, RSMEnv, NPA)	Operations

CHAPTER – EIGHT

8. DECOMMISIONING

8.1 Introduction

Decommissioning is the safe and environmentally sound removal, disposal, and repurposing of obsolete infrastructure. It marks the end of an asset's operational life cycle from the project site. The operation life span of the proposed Project and the associated facilities is anticipated to be 30 years. It is however highly unlikely that Project infrastructure would be decommissioned and abandoned as infrastructure of this nature is usually upgraded or rehabilitated to enable them to continue to function optimally for as long as possible.

Given the expected lifespan of the proposed Project, a detailed Decommissioning Plan is not warranted. Moreover, the baseline conditions associated with the Project areas and surrounds are likely to be significantly different to what it is today. When the proposed MM FZE Port Project reaches end of life and should decommissioning be required then this would need to be assessed under a separate Environmental and Social study and a Decommissioning Plan should be developed in this regard.

8.2 Decommissioning Plan

In the unlikely event that MM FZE decides to decommission the Port Facility, MM FZE will carry out an assessment and inventory of the existing infrastructure to determine specific decommissioning requirements. This process will involve stock take of existing components of the facility at the time. On completion of the assessment, an appropriate and systematic Decommissioning Plan will be designed.

The Decommissioning Plan will take into account the most cost-effective and practicable methods associated with decommissioning, E&S considerations, legal requirements and Global International Industry Practice (GIIP) at the time. In addition, the Plan shall contain an adaptive management component that allows for the incorporation of lessons learned from monitoring data during the operation of the Facility. The Decommissioning Plan shall specify all activities that will be undertaken during the decommissioning and abandonment of the Project.

An effective Waste Management Plan (WMP) shall be developed as part of the Decommissioning Plan to ensure proper waste management and protection of the environment. The WMP shall adopt the waste hierarchy specified in this Report i.e., reduce, reuse, recycle, recover and disposal. MM FZE shall take advantage of repurposing obsolete infrastructure, or where repurposing is not possible, identify possible reuse and recycling opportunities. For reuse or recycling opportunities an approved waste contractor will be engaged. Where reuse and recycling is not an option, disposal will be in a government approved landfill site.

The Decommissioning Plan will be submitted to the FMEnv, RSMEnv and other relevant regulatory agencies for approval, at least one year prior to scheduled decommissioning and abandonment.

Decommissioning shall only commence after the approval of the Plan by the regulatory Agencies. MM FZE shall ensure adequate monitoring of all contractors involved in decommissioning and ensure all activities particularly waste handling and disposal are well documented and made available to FMEnv, RSMEnv, RIWAMA and others upon request.

8.3 Decommissioning Programme

The activities that will be undertaken during decommissioning and abandonment of the Project shall include the following stages as detailed in *Sections 8.3.1 - 8.3.6* below:

8.3.1 Stakeholder Engagement

Through adequate planning and stakeholder engagement, communities can be better equipped to adapt to a decommissioning scenario, as well as to investigate alternative livelihood sources. Therefore, as part of the Decommissioning Plan, a decommissioning, abandonment and remediation programme shall commence following the active engagement with stakeholders including facility workers (MM FZE staff and other operational staff), affected communities and other relevant local and national regulatory agencies such as the Nigerian Ports Authority (NPA), National Inland Waterway Authority; Nigerian Maritime Administration and Safety Agency (NIMASA); and the Nigeria Export Processing Zones. Relevant information regarding the Plan shall be disclosed to workers to ensure they receive adequate notice of dismissal and severance payments in line with national legislation and collective agreements in a timely manner.

8.3.2 Dismantling and Removal of Project Components

This process will entail dismantling and removal of Project components and associated facilities. As some of these materials can be reused or recycled, MM FZE shall consider working with manufacturers or recycling industries or approved vendors to recycle these materials depending on their condition. Other non-recyclable or reusable materials shall be evacuated and disposed by an approved municipal waste contractor in line with the WMP.

8.3.3 Demolition of Buildings and Structures

Buildings and structures such as administrative buildings, workshop/maintenance area, storage area for lubrication oil and water treatment chemicals, security building etc., shall be demolished. All reusable materials from buildings such as metal scraps, pipes, doors, glass etc. shall be preserved for reuse or recycling, while rubbles shall be evacuated by an approved municipal waste contractor.

8.3.4 Site Remediation and Restoration/Revegetation

Following actual decommissioning activities and evacuation of all equipment, rubbles and waste from the site, remediation and restoration including revegetation shall commence as soon as practicable. During this stage, the site will be stabilized and levelled back to its original state as much as possible to enhance drainage. Site restoration activities shall also include the following as appropriate:

- Re-contouring and grading of land to blend with natural topography.
- Planting of native plant species that are dominant within the plant communities in adjacent areas with similar soil conditions to re-establish vegetation. The cover, species composition, and diversity of the re-established plant community shall be similar to those present on-site prior to project development and in the vicinity of the site. The baseline data of existing ecological biodiversity of the Project Site contained in *Chapter 4* of this Report shall be a benchmark for selecting the appropriate plant species for revegetation.
- Installation of erosion protection structures such as sediment traps, riprap, gabions, etc. wherever possible to capture run-off sediments and protect the new vegetation.
- Managing the encroachment of alien plant species on the site.

8.3.5 Assessment of Residual Impacts

Following decommissioning, the Project Site shall be assessed for any residual impacts on the various components of the environment especially air, soil and surface water. Any suspected contaminated resource shall be remediated. Similarly, the residual impacts of the Project on the socio-economic aspect of affected communities shall be assessed with appropriate compensatory measures established and implemented in conjunction with affected communities and regulatory authorities.

8.3.6 Monitoring

To ensure rapid and successful re-establishment of vegetation cover and site restoration, the abandonment, decommissioning, and remediation plan shall specify site-specific measurable success criteria with target dates (monitoring data) to allow effective monitoring of the site. These monitoring data shall be used to determine the success of reclamation activities and the need for changes in ongoing management or for additional reclamation measures. Periodic visual inspections for a minimum of two years following decommissioning activities shall be required to ensure that there is adequate restoration and minimal environmental degradation. This period shall be extended until satisfactory results are obtained. Vegetation re-establishment efforts shall continue until all success criteria have been met.

8.4 Envisaged Risks and Impacts of Decommissioning Activities

Potential E&S risks and impacts may arise as the Project approaches the end of its viable life and enters into a downscaling and ultimate decommissioning phase. Impacts are associated with dismantling and removal of infrastructure and equipment, as well as demolition and evacuation of structures. The negative potential E&S risks and impacts may include:

- Improper abandonment of the Project site.
- Increased susceptibility of the site to soil erosion.

- Generation of non-hazardous and hazardous wastes including scrap metals, batteries, spent oils etc.
- Soil contamination from spills/leaks of fuels, oils and indiscriminate disposal of wastes.
- Sedimentation and contamination of surface water bodies and attendant loss of aquatic flora and fauna.
- Loss of employment for port operational staff.
- Loss of business and economic livelihood for value chain workers.
- Increased susceptibility of surrounding communities to vector borne and water borne diseases.
- Risk of occupational health and safety accidents and injuries.

The management actions to avoid or minimize these impacts will be a key consideration of the Decommissioning Plan. Other potential likely impacts which may not have been envisaged at this stage based on new legislations, changes in site conditions etc., shall also be assessed as part of the Environmental and Social Study specific to the decommissioning.

CHAPTER – NINE

9 CONCLUSIONS AND RECOMMENDATIONS

An extensive risk assessment was undertaken during the ESIA process where a range of potential impacts to the physical, biological, and social environment were identified and assessed. Where risks and impacts have been identified, appropriate mitigation measures have been provided in the ESIA. It should be noted that for many of the impacts identified, the proposed mitigation measures will reduce the significance of the impacts to a minor or negligible level. However, for some impacts, even with mitigation, residual impacts will remain. Those impacts that have a moderate post-mitigation (residual) significance, and which will require careful and consistent ongoing management, include:

- **Underwater Noise**: Impacts related to underwater construction noise on mammals and other estuarine biota other mammals. The most sensitive receptors are likely to be the IUCN Critically Endangered Atlantic Humpback Dolphin, which is a highly noise-sensitive species.
- **Accidental/Potential Spills**: Impacts related to potential spills of ammonia-derived products, fuel spills and catastrophic loss of containment would affect a wide range of organisms, including those important for ecosystem services such as fisheries.
- **Road Safety Risks**: Local road users, including market traders, pedestrians, and local vehicular traffic, are sensitive to potential road safety impacts. Groups such as school children, pregnant women, and people with disabilities are particularly vulnerable to road safety incidents.
- **Construction of Surface Infrastructure**: The soils of the site have a medium sensitivity. Disturbance of the soil can lead to increased erosion, and contamination from surface can migrate towards the water table where it joins the saturated zone
- **Saltwater Intrusion on the Groundwater Resource**: abstraction of groundwater from the water supply wells is expected lead to a potential drawdown in groundwater level in the surrounding aquifers, which in turn may lead to saltwater intrusion from the Bonny River.
- **Chemical and Hydrocarbon Spills on the Groundwater Resource** may arise from heavy machinery and vehicles operational on site
- **Transport, Loading and Storage of Urea**: During transport, unloading of the transport trucks, and conveying of urea into the urea warehouse accidental spills could occur, which could impact the groundwater resource quality
- **Transport, Loading and Storage of Ammonia**: Ammonia produced at the manufacturing site will be transported to the Terminal by means of dedicated tankers and unloaded and stored in an Ammonia Storage Tank for export
- **Unforeseen Impacts on Terrestrial Biodiversity**: Moderate to high volumes of hydrocarbons could be spilled on the site or quay, and rapidly move into water from where downstream or nearby

habitats may be polluted, of which mangroves are likely to be most impacted. Moderate to high volumes of ammonia and/or urea could be spilled and rapidly spread into surrounding habitats and/or be transported further by water. Emergency flaring, if required, may catch fauna unawares and cause injury or death, especially if this occurs at night, affecting fauna happening to be in close proximity to the flare stack

- **Unplanned events**: including fuel spills and other pollution, spills of ammonia, urea products and loss of containment.

The ESIA process should not stop with the submission of this ESIA report and associated ESMMP to FMEnv. Upon submission, there will be need for continued work and monitoring of environmental components. Where any changes are observed, these will be assessed in terms of their potential to alter the ESIA findings. Some changes may not result in a material change to the ESIA findings; however, any further changes to Project scope should be re-evaluated in terms of the influence on impact significance, and if necessary, mitigation / management measures included in the ESMMP will be amended to ensure negative impacts are mitigated and positive impacts enhanced. Typically, such substantive changes will be submitted as an addendum to this ESIA.

To provide the vehicle for the integrated management of the potential impacts identified in the ESIA (both positive and negative) an Environmental and Social Management System (ESMS) will need to be implemented. The ESMS provides a mechanism for ensuring that mitigation measures identified in the ESIA and associated ESMMP are adequately implemented. Moreover, the ESMS provides a framework for monitoring, compliance auditing and inspection programmes, which assist the Project in meeting its commitments, as stipulated in Nigerian regulations and lender standards (primarily the IFC PSs).

Provided that all the E&S mitigation / management measures provided in this ESIA Report and associated ESMMP are implemented, it can be concluded that there are no E&S fatal flaws which inhibit authorisation of the proposed MM FZE Project.

Moreover, the positive benefits of the proposed Project also need to be considered in the authorisation decision. These positive benefits, provided in more detail under the Project Justification (*Chapter 2*), include: improving regional fertilizer supply and ultimately impacting positively to food security of the world and Africa at large, generation of revenue to the country contributing to Nigeria's goal to becoming a net exporter of Urea fertilizer in the region and the provision of new employment opportunities for the growing demand from the young Nigerian population. With all three IEFCL units (Train1, 2 & 3) in operation, MM FZE will use the new Port Terminal to export the surplus 150KT ammonia and 1.4 million tons of urea. Overall, the Project will be able to derive valuable foreign exchange from the Urea and Ammonia that will be exported, as well as improve the local economy in the immediate Project area.

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Appendix – A

Environmental and Social Impact Assessment for the Proposed MM FZE at Federal Ocean Terminal, Onne Port Complex, Onne, Rivers State

Environmental and Social Management and Monitoring Plan (ESMMP)

CONTENTS

LIST OF TABLES

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ACRONYMS AND ABBREVIATIONS

Acronyms	Description
CCRA	Climate Change Risk Assessment
CO2	Carbon Dioxide
DM	Demineralized
ES	Ecosystem Services
E&S	Environment and Social
ESMMP	Environmental and Social Management and Monitoring Plan
ERM	Environmental Resources Management Southern Africa (Pty) Ltd
ESMMP	Environmental and Social Management and Monitoring Plan
FMEnv	Federal Ministry of Environment
GHG	Green House Gas
GIS	Geographic Information System
H&S	Health and Safety
IBAT	Integrated Biodiversity Assessment Tool
MM FZE	Indorama Eleme Fertilizer and Chemicals Limited
IFC PSs	International Finance Corporation Performance Standards
IUCN	International Union for Conservation of Nature
MTPD	Metric Tonnes Per Day
NG	Natural Gas
VOCs	Volatile Organic Compounds

1. INTRODUCTION

1.1 TERMS OF REFERENCE

Meliora Methanol Free Zone Enterprise (MM FZE), a subsidiary of Indorama Group has commissioned Environmental Resources Management Southern Africa (Pty) Ltd (ERM) to undertake an Environmental and Social Impact Assessment (ESIA) study for the proposed construction and operation of the MM Port FZE Facility at the Federal Ocean Terminal, Onne Port Complex, Onne, Eleme Local Government Area, Rivers State, Nigeria (hereafter referred to as the Project).

As part of the environmental approval process for the proposed MM FZE Port Project, a simple and easy to implement Environmental and Social Management and Monitoring Plan (ESMMP) is needed to address the Project risks and impacts identified in the ESIA. This document therefore presents the ESMMP for the proposed MM FZE Port Project.

This ESMMP sets out a formal system by which the Project can manage mitigation commitments during the construction and operational phases.

1.2 STRUCTURE OF THIS ESMMP

The structure of this ESMMP is as follows:

- **Chapter 1 (Introduction)** – presents the terms of reference for the ESMMP, purpose and objectives of the ESMMP, and details of MM FZE.
- **Chapter 2 (Summary of Project Description)** – presents an overview of the proposed MM FZE Port Project, specifications, and activities.
- **Chapter 3 (Environmental and Social Management System)** – presents a framework for the system necessary for the integrated management of the ESMMP.
- **Chapter 4 (Legal Framework and International Best Practice)** – summarises relevant legal and international good practice requirements related to environmental and social compliance.
- **Chapter 5 (Key Sensitivities)** – summarises key physical, biophysical, and socio-economic sensitivities of the proposed MM FZE Port Project to contextualise the key areas for environmental management interventions.
- **Chapter 6 (Implementation of the ESMMP)** – summarises the institutional arrangements required for governance, implementation, and monitoring of the ESMMP.
- **Chapter 7 (Environmental and Social Management Plan)** – describes the objectives, performance requirements/standards, and mitigation requirements relevant to all construction and operational activities separated by environmental and social receptors (e.g., air, noise, water, biodiversity etc.).
- **Chapter 8 (Environmental and Social Monitoring)** – describes the monitoring requirements for air, soil, water, biodiversity etc. for construction and operation phases.

1.3 PURPOSE AND OBJECTIVES OF THE ESMMP

Note:

This ESMMP has been compiled to address the E&S impacts that are anticipated to occur during the various implementation phases of the proposed MM FZE Port Project, as identified in the ESIA. This ESMMP should not be regarded as complete or final and requires a mechanism to manage change. This mechanism must ensure that changes to the scope of the proposed MM FZE Port Project are subjected to a robust social and environmental assessment process. Any changes to Project scope or new substantive E&S findings will be evaluated for their degree of significance, and will be incorporated into the appropriate Project documentation as follows:

- Minor changes will be reflected in updates to the ESMMP; and
- Substantive design changes that might potentially alter the ESIA findings (i.e., those that result in changes to the predicted significance of environmental and social impacts) will be subject to re-assessment, further stakeholder consultation, supplementary reporting and revision of the proposed MM FZE Port Project's ESMMP.

This ESMMP has been prepared to cover the activities associated with the proposed MM FZE Port Project during all phases (pre-construction, construction, and post construction/operation). The ESMMP covers the management measures for implementation by the Contractor and associated subcontractors during construction of the proposed MM FZE Port Project and measures that fall under the responsibility of the MM FZE. Monitoring measures to be undertaken by the Contractor and MM FZE are covered in Section 7.

The purpose of this ESMMP is to outline appropriate management strategies and actions to mitigate negative impacts and enhance beneficial impacts of the proposed MM FZE Port Project through all the phases. The purpose is also to provide a basis for an on-site E&S Manual for staff, maintenance personnel, contractors, and consultants with responsibilities for the proposed MM FZE Port Project. The ESMMP includes the monitoring requirements to measure the efficacy of the mitigation measures and to enable adaptive management to correct mitigation requirements (Section 8).

Each management action is designed to be practical, measurable, and auditable. Given the expected lifespan of the proposed MM Port FZE Project, an ESMMP for decommissioning is not warranted, as the proposed MM FZE Port Project is not expected to be decommissioned at any foreseeable time. Moreover, the baseline conditions associated with the Project areas and surrounds are likely to be significantly different to what it is today. When the proposed MM FZE Port Project reaches end of life and should decommissioning be required then this would need to be assessed under a separate ESIA process and a separate ESMMP should be developed in this regard.

The objectives of this ESMMP are to provide:

- E&S management procedures and mitigation measures for the control of Project impacts and to monitor compliance with the E&S requirements.
- E&S performance indicators, monitoring requirements and review procedures for activities associated with the proposed MM FZE Port Project.
- Government authorities, stakeholders, and MM FZE with assurance that mitigation measures will be addressed, are achievable, and a common basis for measuring compliance with specific mitigation requirements.
- Stakeholders with assurance that identified mitigation measures to address impacts are documented, and that the E&S management of the proposed MM FZE Port Project can reduce negative impacts and optimize or enhance positive impacts.

> **NOTE**:
>
> As the proponent, MM FZE will have ultimate responsibility for implementing the ESMMP.

1.4 DETAILS OF PROPONENT

The proponent of the proposed Project is MM FZE, Federal Ocean Terminal (FOT), Onne Port Complex, Oil & Gas Free Zone, Onne, Eleme LGA, Rivers State. It is the MM FZE's intent to establish the proposed Project, and required associated facilities, from concept to construction and subsequent operation in line with the National Guidelines on manufacturing sector and in accordance with international best practice (IBP). The contact details for the applicant are as follows:

INDORAMA

Contact: Mr. Gowdara Manjunath

Meliora Methanol FZE

(FZE Licence No FZ/0/01/00307)

Federal Ocean Terminal, Onne Port Complex, Oil & Gas Free Zone Onne,

Eleme LGA, Port Harcourt, Rivers State, Nigeria

2. SUMMARY OF PROJECT DESCRIPTION

2.1 PROJECT OVERVIEW AND BACKGROUND

IEFCL is a major producer of urea fertilizer, with a facility situated on a site of approximately 51 hectares (ha) within the 361 ha Indorama manufacturing complex at Eleme, Nigeria. The operations consist of petrochemical manufacturing facilities run by Indorama Eleme Petrochemicals Limited (IEPL) and fertilizer manufacturing facilities that are run by Indorama Eleme Fertilizer and Chemicals Limited (IEFCL) within the Indorama manufacturing complex. Current manufacturing capacity is 2.8 MMTA of Urea & 400 KTA of Polymers (Polyethylene & Polypropylene), utilizing Natural Gas & Natural Gas Liquids as feedstock. The Petrochemical manufacturing facilities comprising of the Cracker, Polyethylene and Polypropylene plants have been in operation since 2006. The Fertilizer manufacturing facilities consist of the Train 1 and Train 2 lines, which both independently produce 2,300 and 4,000 metric tons per day (MTPD) of ammonia and urea respectively. It should be noted that an ESIA study was commissioned for Train 3 in January 2023, and this Report was submitted to the Federal Ministry of Environment (FMEnv) on 26th May 2023 and International Finance Corporation (IFC) for approval. The Train 3 expansion project consists of the development of an additional ammonia and urea train, with a design capacity of 2,300 MTPD of ammonia and 4,000 MTPD of urea. This ESIA Report of Train 3 was approved by the Federal Ministry of Environment (FMEnv) vide letter number FMEnv/EA/EIA/6063/Vol.1/243 dated 6th September 2023.

After the commissioning of the IEFCL Train 3 expansion Project, there will be surplus ammonia of approximately 420 MTPD over and above the amount required for the Urea plants. IEFCL is planning to export this surplus liquid ammonia and 1.4 Million Metric Tons per Annum (MMTPA) of Urea through the facilities at the proposed MM FZE Port Terminal.

The proposed Project entails the construction and operation of a new Port terminal with all associated utilities to export Urea and Ammonia. This new terminal is proposed to be situated within the existing Onne Port Complex about 20 km to the south of the manufacturing site at the existing Indorama Complex (Figure 2-1).The terminal shall have one berth with a capacity to handle and export 1.4 MMTPA of granulated Urea and about 150 Kilotons per Annum (KTA) which is approximately 420 Metric Tons per Day (MTPD)) of Ammonia. Moreover, the terminal will include separate Urea and Ammonia storage and handling systems and associated facilities, including – a quay designed for mooring and loading of vessels; a boil of gas (BOG) unit for compression and liquification of ammonia vapors; an ammonia pumping station from the storage tank to ship; a jetty loading system for Urea; and a jetty loading arm for Ammonia. The Project also includes a compressed natural gas storage module to be used for power generation. Power generation will be by means of three gas engine generators with a capacity of 1,500 (Kilovolt Amperes) kVA and one generator with a capacity of 800 kVA. The number of generators, capacity and generating voltage shall be confirmed during the detailed engineering phase of the Project. Natural gas shall be stored at high pressure in a stationary cascade at the terminal.

2.2 PROJECT LOCATION

The Project is situated at the existing Onne Port Complex on a plot of land with a waterfront of approx. 350 meters (m) with all associated utilities, in order to export Urea and Ammonia. The Project area borders the undeveloped land to the north and east, the Operational Onne

Multipurpose Terminal (OMT) to the west and waterfront at the south. The total footprint of the Project is 20 hectares (ha) and the coordinates of the Project site are Latitude 4050’3” to 4050’52” N and Longitude 706’29” to 706’55” E.

2.3 PROJECT DESIGN

At the end of the design phase, the proposed Project will be dimensionally correct and as such the main components of the Project can be fully described. It is during this phase that the outcomes of the ESIA will influence how the proposed Project develops. Project planning, decision-making and refinement of the Project will continue throughout the design phase, as a result of continued engineering studies, as well as per the findings of this ESIA and associated ESMMP.

The Project design in terms of equipment design, layout, etc. is similar to the port terminal “OIS Indorama Port Limited” for Urea export, which is located within Onne Port Complex that is already in operation. MM FZE intends to engage established Construction Contractors for the Project. The following is important to note:

- The Project will have an operational lifespan of 30 years.
- The proposed Plant will operate 330 days/year.

The new port terminal will house Urea storage and handling system, Ammonia storage and handling system and associated facilities detailed in the Sections which follow. The new port terminal will have facilities as mentioned below:

Urea Storage and Handling

- Intake system
  - Truck weighbridges (incoming and outgoing)
  - Truck unloading station (TUS) simultaneously four trucks.
  - Conveying system from TUS to urea storage by means of belt conveyors, bucket elevator and reversible shuttle conveyor.
  - De-dusting system
- Storage
  - Warehouse having capacity 52000 MT.
  - Air handling units
- Outtake system
  - Portal reclaimer
  - Belt conveyors
  - Ship loader on jetty
  - De-dusting systems
  - Belt weigher
- Ammonia Storage and Handling
  - Ammonia Tanker Unloading System
  - Ammonia Storage Tanks
  - Flare stack for Ammonia Storage Tank
  - Boil of Gas (BOG) Reliquefication Unit

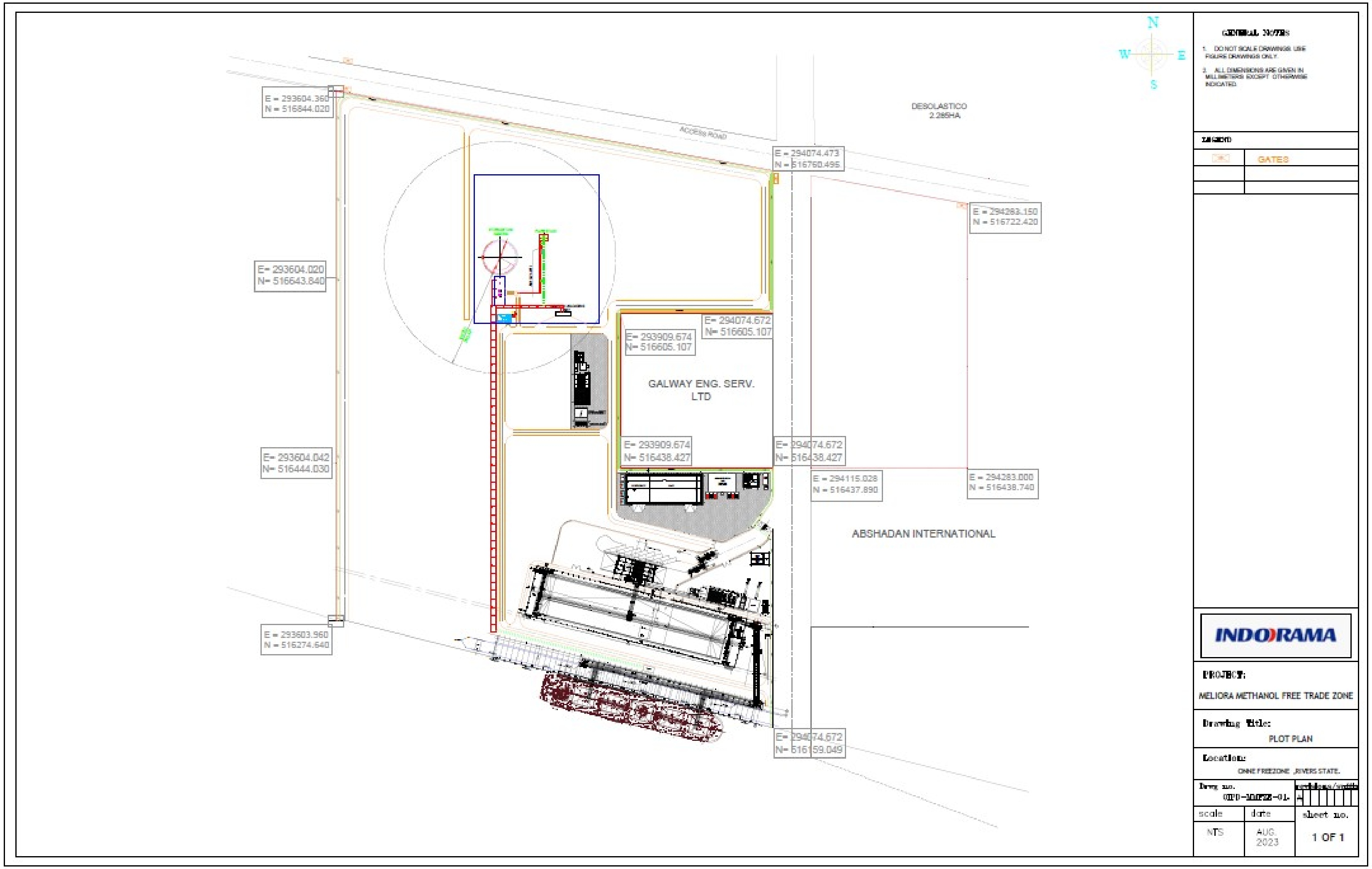
- Ammonia Ship Loading Pumps

- Jetty top side facilities
  - Ammonia Marine Loading Arms
  - Urea Loading System
- Utilities and Other Facilities
  - Cooling Water System for BOG Unit and air compressors
  - Plant air, Instrument Air Unit, and nitrogen storage
  - Natural gas-powered generation unit inclusive of substation and distribution unit.
  - Compressed Natural Gas (CNG) storage modules.
  - Two borewells, each with a capacity of 20~25 cubic metres per hour (m3/hr).
  - Storage of groundwater from the two borewells, treatment, and distribution system.
  - Sewage treatment plant
  - Two weighbridges of 100 Metric Tonnes (MT).
  - Firefighting System Fire water pumps (sea water) and fire water network.
  - Fire & Gas Detection and Protection System.
- Buildings: The new port terminal will also have below mentioned buildings,
  - Workshop / Maintenance area
  - Storage area for lubrication Oil and water treatment chemicals
  - Materials Management Department Building
  - Administration and Security Building

2.4 CONSTRUCTION PHASE

The construction phase will not commence prior to the approval of the associated ESIA study. It is assumed that construction will continue for approx. 22 months. Activities during the construction phase will typically involve pile installation, dredging, excavation works, concrete casting, civil works (specifically equipment foundations), installation of prefabricated structures & equipment, and establishment of the infrastructure. No construction activities will be undertaken at night.

FIGURE 2-1 SITING AND LAYOUT OF KEY INFRASTRUCTURE ASSOCIATED WITH THE MM FZE PROJECT



2.5 OPERATIONAL PHASE

The operational phase will comprise of the following:

2.5.1 DETAILED PROJECT FACILITIES AND PROCESS

The new port terminal will be used for exporting of 1.4 MMTPA Urea and 150 KTPA of Ammonia. The block process flow of Ammonia and Urea handling is shown in Figure 2-2.Brief details of the proposed facilities are discussed in Section 2.5.2 and Section 2.5.3.

2.5.2 UREA STORAGE AND HANDLING

Urea produced at the manufacturing site will be transported to the new port terminal through covered tipper trucks with 40 MT payload capacity. Urea will be unloaded and stored in the Urea warehouse and loaded to Ultramax and Handymax bulk carriers.

2.5.3 AMMONIA TANKER UNLOADING STATION

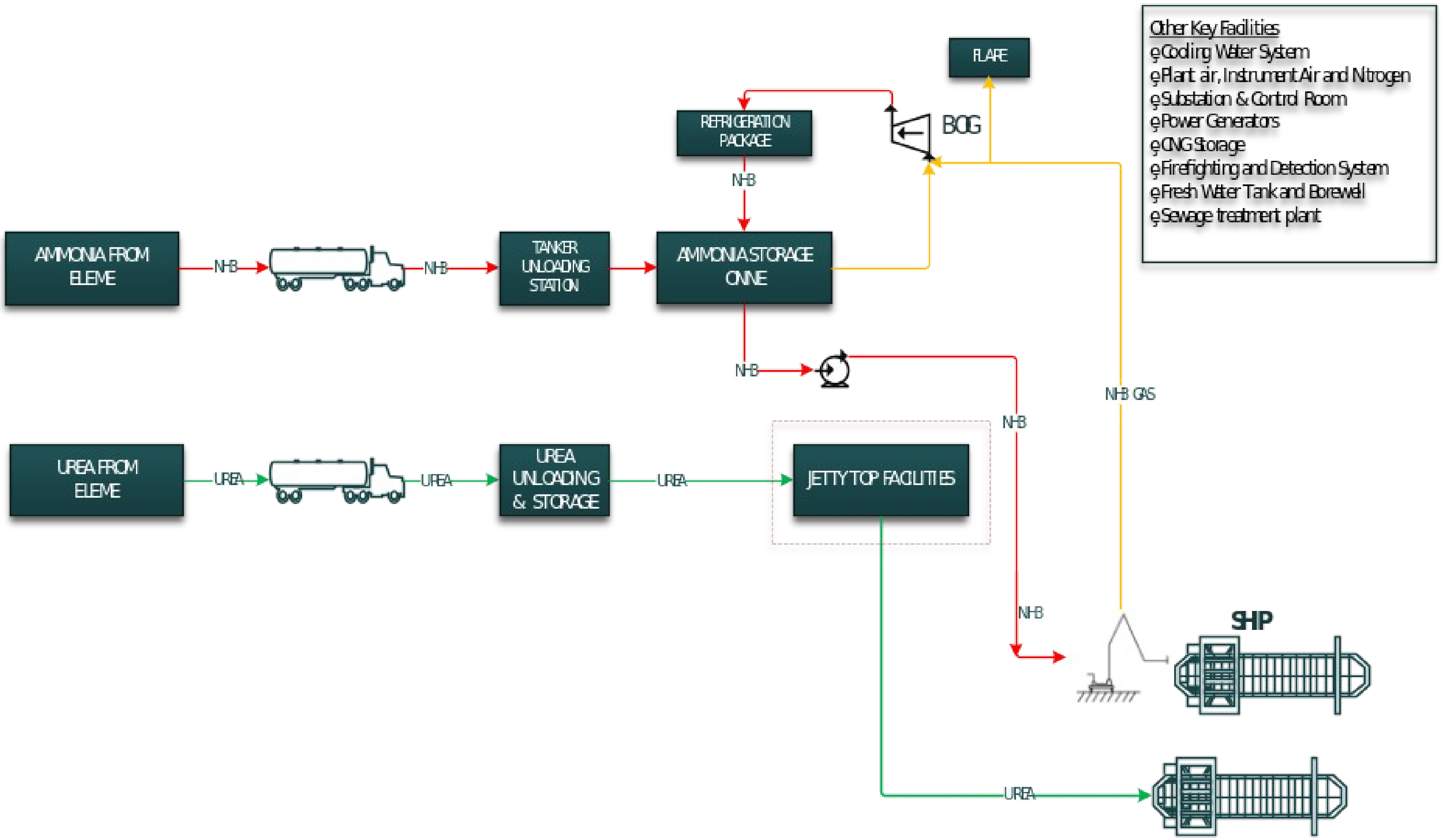
Ammonia produced at the manufacturing site will be transported to the new port terminal by dedicated tankers. The ammonia will be unloaded and stored in the Ammonia Storage Tank for export.

The Detailed Engineering Contractor (DEC) will undertake the engineering of the tanker unloading station for the receipt/unloading of liquid ammonia. Ammonia will be transported from the manufacturing complex to Port by dedicated tankers. The unloading station will have all the facilities required to unload two tankers of approximately 20 MT capacity each, simultaneously within an hour. The expected surplus liquid ammonia receipt at the new port terminal will be about 420 MTPD (150 KTA).

2.6 DECOMMISSIONING PHASE

Activities during the decommissioning phase will involve demolition and site clean-up, disposal of waste, demobilisation of the workers, and a final site review. Decommissioning is anticipated to take place 30 years from now, and the baseline conditions associated with the Project and surrounds are likely to be significantly different to what it is today. When the Project reaches its end of life and decommissioning be required, then this would need to be assessed under a separate Environmental and Social Study and a separate ESMMP should be developed in this regard.

FIGURE 2-2 BLOCK PROCESS FLOW OF AMMONIA AND UREA HANDLING



2.7 PROCESS UTILITIES

Utilities and other facilities required for the new port terminal are as follows:

- **Cooling Water System (Package Unit):** Cooling water is needed for the BOG unit and air compressors. The cooling tower will be a package unit having modular construction with Fibre-reinforced plastic (FRP) material, induced draft, and evaporative type. The location will be closer to the BOG Unit.
- **Plant Air, Instrument Air Unit (Package Unit), and Nitrogen Storage:** Based on the overall requirement of Plant and Instrument air, compressors of suitable capacity will be installed. A PSA (package unit) type instrument air drier unit will be considered for generating instrument air as per the requirement. Plant air and instrument air will be routed through individual buffer vessels having adequate hold-up volume to provide back-up during any disturbance in plant air / instrument air generation facility.
- **Electrical:** The power required for the facilities / equipment at the new port terminal (including power required for Urea Handling System) will be generated by means of natural gas engine driven power generation unit with associated sub-systems will be considered to meet the power requirement. Capacity of gas engine generators will be: 3 units (generators) with a capacity of 1,500 Kilovolt-amps (KVA); and 1 unit each with a capacity of 800 KVA and 500KVA.

  There will be one substation which will house all the electrical systems for the Ammonia and Urea Handling facility. The substation will comprise of substation building, transformers, bus bars, circuit breakers, power distribution board / panels, UPS, etc. The Sub Station building will include Air conditioning.

  The generated power will be stepped down to the required voltage levels (415/230V) for further distribution to electric drives. The Substation will be designed for two (02) voltage levels, i.e., 3.3 kV and 415 volts alternating current (V AC) to cater for the power requirements of entire facility / equipment of the new port terminal.

  Operations of the entire new port terminal will be monitored from a dedicated operation room inside the administrative building. The operation room will accommodate the supervisory control and data acquisition (SCADA) for Ammonia storage/handling system designed by a detailed engineering contractor. The SCADA supplied by the Urea storage/handling system contractor will also be housed in this room.
- **Compressed Natural Gas (CNG) Storage Module:** The natural gas required for power generation will be stored at high pressure in a stationary cascade at the new port terminal. The refilling of the stationary cascade will be undertaken by truck mounted mobile cascades, which will transport the CNG from the manufacturing unit at Eleme to the new port terminal.
- **Bore-Well and Water Storage, Treatment and Distribution.** Two bore-wells each having capacity of 20~25 m3/hr will be developed at the new port terminal. The ground water extracted by bore-well pumps will be stored in storage tank of suitable capacity. The water will be supplied to the point of use based on the requirement.

  Sea water will be used for the fire water requirement of the terminal and a fire water pump house will be constructed near the shoreline. Sea water will be pumped from the fire water pumping station and distributed within the new port terminal area through an underground/aboveground fire water piping network.

Fire and Gas (including Ammonia) detection and protection systems will be considered for all facilities (excluding Urea Handling system). The fire and gas detection and protection will be a packaged system procured by Indorama.

The sewage generated in the entire new port terminal area will be appropriately treated before discharging it outside of premises. A package sewage treatment unit of suitable size will be considered for treatment and disposal.

- **Weigh Bridge:** Two Weighbridges of 100 MT will be installed for both Incoming and Outgoing trucks.
- **Common Facilities at New Port Terminal:** The following buildings are considered at new port terminal. The Civil design (civil outline drawing, layout and foundation design) of these buildings is in Contractor’s scope, Workshop / Maintenance area; Storage area for Oil and chemicals; Material Management Department Building; and Administration and Security Building which will house the operation room.

2.8 WASTE MANAGEMENT

Wastes generated from Project activities can be categorised as non-hazardous or hazardous according to their types and associated risks. The anticipated wastes from construction and operational phase are presented below:

- **Construction Phase** –. Jetty construction will require dredging works using a CSD and TSHD. The dredged material to the volume of 2,000,000 m3, is anticipated to be disposed at the NPA identified area according to MARPOL 73/78 regulations, Nigerian standards, the NPA and waste disposal best practice.
- **Operational Phase** – Operational waste includes possible hydrocarbon spillages from vessels during export activities. An offshore and onshore Waste Management Plan (WMP) will be implemented as part of the installation as well as operation activities. Waste management during the Project activities will comply with applicable Nigerian legislation and The International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78.

  Where permitted under MARPOL 73/78 Annex V, food waste may be discharged at sea. Ground or crushed food waste is permitted for discharge at more than 3 nautical miles from the nearest land. Non ground or crushed food waste is permitted for discharge at more than 12 nautical miles from the nearest land.

  A 20 kilo litres per day (KLD) package sewage treatment plant will be installed to effectively treat the sewage effluent generated from office activities. The treated sewage water quality conforms to the FMEnv and IFC standards.

  Wastewater generated from toilets, bathrooms and kitchens will be collected via a series of drainpipes and finally will be collected in a sewage collection tank which is fully enclosed and covered with a slab. Oil and grease traps will be provided in a collection tank. Treatment of collected sewage will follow the following treatment process.

2.9 EMPLOYMENT AND WORKING HOURS

The normal working hours will be 40 hours per week and 176 hours per month as stipulated in Nigerian Labour Laws and Internal Labour Organisation (ILO) conventions.

3. ENVIRONMENTAL AND SOCIAL MANAGEMENT SYSTEM

3.1 INTRODUCTION

This ESIA has identified potential risks and impacts (both positive and negative) to the physical, natural, and socio-economic environments. In order to avoid, minimise and reduce negative impacts, and to ensure opportunities for the enhancement of positive impacts are realised, E&S Management Plans (Management Plans) have been prepared, and are described in this ESMMP under Section 7 as follows:

- Air Quality Management Plan
- Noise Management Plan
- Soil and Land Use Management Plan
- Ground Water Management Plan
- Surface Water Management Plan
- Estuarine and Aquatic Biodiversity Management Plan
- Terrestrial Biodiversity Management Plan
- Socio-economic Management Plan
- Traffic Management Plan
- Cultural Heritage Management Plan
- Construction Phase Waste Management Plan
- Spill Prevention, Control and Containment Management Plan

The above plans may be combined or included in an overall E&S plan as appropriate to streamline the execution of the Project. Each Management Plan listed above provides the following:

- Objectives and purpose of the Plan;
- Applicable phases of the Project when the Management Plan is required;
- The Project related activity resulting in the impact, requiring the elaboration of each Plan;
- An overview of the responsibility for the implementation of each Plan;
- A summary of the performance criteria to which the Plan must aim to comply (which included Nigerian legal requirements, the IFC PSs, or applicable IBP), that is relevant to each Plan;
- Mitigation measures (actions) required during various Project phases (viz. pre-construction, construction, and operational phases), that were identified and described in the ESIA; and
- Monitoring requirements, including targets, performance indicators and reporting requirements.

3.2 E&S MANAGEMENT SYSTEM

The vehicle for the **integrated** management and **implementation** of these Management Plans is an E&S Management System (ESMS). Therefore, the ESMS is a key component of the ESIA process.

An ESMS is also a requirement of IFC PS 1: Assessment and Management of Environmental and Social Risks and Impacts. The objective of PS 1 is to:

"Identify and evaluate E&S risks and impacts of the Project, adopting a mitigation hierarchy to anticipate and avoid, or where avoidance is not possible, minimise, and, where residual impacts remain, compensate/offset for risks and impacts to workers, affected communities, and the environment, ..." (Undertaken as part of the ESIA process) ... "and to promote improved environmental and social performance of clients through the effective use of management systems...."

The main elements of any given ESMS are provided in Figure 3-3 and comprises the following four phases:

- **Planning** – establishing the objectives and processes necessary to deliver results in accordance with the Project Guideline for Environmental and Social Management.
- **Doing** – Implementing the processes through defining mitigation measures and assigning responsibilities for undertaking or implementing such mitigation measures, typically through suites of Management Plans.
- **Checking** – Monitoring and measuring these processes against the policy, objectives and targets, legal and other requirements (such as those of the IFC), and reporting of the results.
- **Acting –** Taking actions to continually improve performance of the ESMS through the training of personnel and auditing of results.

FIGURE 3-3 THE MAIN ELEMENTS OF AN ESMS

The ESIA process has essentially undertaken most of the initial planning aspects required by an ESMS by identifying environmental and social impacts and formulating Management Plans.

Further elements of an ESMS related to its implementation (doing, checking, and acting), are described in Chapter Error: Reference source not found of this ESMMP under the following sections:

- **Planning / Doing**: Section 6.2 provides the institutional framework, organisational frameworks and specific roles and responsibilities for implementing the ESMS.
- **Planning / Doing:** Section 6.3 outlines plans for on-going stakeholder engagement including the management of community grievances and concerns.
- **Checking / Acting**: Section 6.4 introduces key components for the implementation of the ESMS including training, monitoring, audits and inspections, and reporting.

- **Acting:** Section 6.4.5 explains the system for the management of change during the implementation of the proposed Project.

As such, an ESMS is implemented to:

- Assist management in establishing priorities for E&S impacts.
- Provide a mechanism for ensuring that measures identified in the ESIA and listed in each Management Plan, are addressed, and implemented.
- Track changes in Nigerian legislation and/or Lender standards so that they can be addressed in a timely manner.
- Provide a framework for compliance auditing and inspection programmes.
- Ensure E&S (including Project induced health issues) continue to be integrated into business decisions.
- Provide a framework for mitigating impacts that may be unforeseen or unidentified until construction or operation is underway.
- Encourage and achieve appropriate environmental and social performance and awareness from all employees and contractors.
- Provide assurance to regulators, stakeholders, and lenders that their requirements with respect to environmental and social performance are being managed.

At this stage, MM FZE have a number of environmental, social, occupational health and safety and human resource plans, policies and procedures. These plans, policies and procedures relate to all MM FZE's operations in Port Harcourt. Over the life of all of MM FZE's operations, the vehicle by which the commitments set out in this ESMMP, and other plans, policies and procedures should be developed into specific actions which can be implemented through an overarching ESMS.

Aligned with IFC PS1, as the Project owner MM FZE, is responsible for the development of an ESMS under which all Project operations will be implemented and shall include:

- **Policy Statement** – which described the environmental and social objectives, which will guide MM FZE in achieving environmental and social performance.
- **Process for Risk Identification** – which, in addition to the ESIA, shall include a defined process for evaluating and managing environmental and social risks through life of MM FZE operations.
- **Management Programs** – for environmental and social performance execution which are, in part, detailed for the Project below.
- **Organisation Capacity/Competency** – demonstrated through clear division of responsibility and vetting of individual roles holding responsibility and accountability for environmental and social performance execution.
- **Emergency Preparedness and Response** – a plan which addresses how potential risk impacts resulting in emergency response will be managed for life of Project.
- **Stakeholder Engagement Program** – a program which includes stakeholder analysis and planning, disclosure and dissemination of information, consultation and participation, grievance mechanism, and ongoing reporting to Affected Communities through life of MM FZE operations.
- **Monitoring and Review System** – which will detail the process by which MM FZE will monitor and measure the effectiveness of the management program, including compliance with any regulatory requirements, legal requirements and/or contractual obligations.

4. LEGAL FRAMEWORK AND INTERNATIONAL BEST PRACTICE

This Chapter presents a summary of the legislative and IBP E&S requirements for the proposed MM FZE Project.

4.1 INSTITUTIONAL FRAMEWORK

FMEnv is the principal authority for the regulation and enforcement of environmental laws in Nigeria. The Environmental Impact Assessment Act 86 of 1992 (amended by EIA Act CAP E12 LFN 2004 and Regulations 2021), established by the Ministry, requires that all development and industrial activities, operations and emissions are within the limits prescribed in the national guidelines and standards and comply with relevant regulations for environmental pollution management in Nigeria as and when these are released by the Ministry.

The National Environmental Standards and Regulations Enforcement Agency (NESREA) is charged with the responsibility of enforcing the environmental laws, guidelines, standards, and regulations in Nigeria, specifically during the operational phase of development Project.

4.2 NATIONAL REGULATORY FRAMEWORK

The following national policies and regulations have E&S implications that pertain to the Project and this ESMMP:

- **National Policies:**
  - National Policy on the Environment, 1989
  - National Climate Change Policy for Nigeria, 2021
  - National Gender Policy, 2021
  - National Policy on Occupational Safety and Health, 2021
  - National policy on Solid Waste Management, 2020
  - National Environmental Sanitation Policy, 2005
  - National Agriculture Promotion Policy, 2016
- **General Environmental:**
  - Environmental Impact Assessment Act 86 of 1992 (amended by EIA Act CAP E12 LFN 2004)
  - Environment Impact Assessment Procedures and Charges Regulations, 2021, S.I 109
  - National Environmental Impact Assessment Procedural and Sectoral Guidelines, 1994
- **Waste and Pollution:**
  - National Environmental (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations, 1991, S.I.
  - National Environmental Protection (Effluent Limitation) Regulation 1991, S.I.8
  - National Environmental (Management of Solid and Hazardous Wastes) Regulations, 1991, S.I.15
  - National Environmental (Sanitation and Wastes Control) Regulations, 2009, S.I.28

- **Soils and Water:**
  - National Environmental (Soil Erosion and Flood Control) Regulations, 2011, S.I.12
  - National Environmental (Surface and Groundwater Quality Control) Regulations, 2011, S.I.22
  - Water Resources Act, CAP W2 LFN, 2004
- **Climate Change:**
  - Climate Change Act, 2021
- **Air Quality:**
  - National Environmental (Air Quality and Control) Regulations, 2021
- **Noise:**
  - National Environmental (Noise Standards and Control) Regulations, 2009, S.I.35
- **Biodiversity:**
  - National Environmental (Control of Alien and Invasive Species) Regulations, 2013, S.I.32
  - Endangered Species Act CAP E9 LFN, 2004 as amended 2016
  - Environmental (Protection of Endangered species in International Trade) Regulations 2011, S.I. 16
- **Health, Safety and Labour:**
  - Factories Act, CAP F1 LFN 2004
  - Labour Act, CAP L1 LFN 2004
  - Trade Unions Act, 2005
  - Employee Compensation Act, 2010
  - Pension Reform Act, 2014
  - Violence against Persons (Prohibition) Act, 2005
  - National Minimum Wages Act, 2019
  - National Health Insurance Authority Act, 2022
  - National Employment Laws and Regulations, 2023
- **Land:**
  - Land Use Act CAP L5 LFN, 2004
- **Other:**
  - National Environmental (Ozone Layer Protection) Regulations, 2009, S.I.32
  - National Environmental (Construction Sector) Regulations (S.I No. 19), 2011
  - Harmful Waste (Special Criminal Provisions) Act CAP H1 LFN, 2004
  - Criminal Code of 1990 (now CAP 38 LFN, 2004)
  - The Standards Organization of Nigeria (SON) ACT NO. 14, 2015
  - Nigerian Ports Authority Act, 1999
  - National Inland Waterway Authority Act 2016
  - Nigerian Maritime Administration and Safety Agency (NIMASA) Regulations 2014

- Investment Procedures, Regulations and Operational Guidelines for Free Zones in Nigeria, 2004
- Nigeria Export Processing Zones Act No 63 of 1992
- Onne Oil and Gas Free Zone Authority Act No. 8 of 1996
- Criminal Code of 1990 (now CAP 38 LFN, 2004)

- **State Laws:**
  - Rivers State Noise Control Edict, No. 20, 1985
  - Rivers State Environmental Protection and Management Law, CAP A42, 2019

  The ESIA and associated ESMMP (this document) has considered the provisions included in the abovementioned national policies and regulations. Descriptions of each policy and regulation mentioned above together with its applicability to the Project is provided in Chapter 1 of the ESIA.

4.3 INTERNATIONAL CONVENTIONS, PROTOCOLS AND AGREEMENTS

Nigeria is a signatory to several international conventions and agreements targeted toward the conservation and protection of the environment to ensure sustainable development. The relevant international conventions, protocols, and agreements most applicable to the Project and this ESMMP include:

- The Paris Accord, 2015
- International Health Regulations (IHR), 2005
- International Labour Organization (ILO): ILO-OSH, 2001 - Guidelines on Occupational Safety and Health (OSH) Management
- The United Nations Convention on Biological Diversity, 1994
- The Rio Declaration on Environment and Development, 1992
- The United Nations Framework Convention on Climate Change, 1992
- International Convention on Oil Pollution Preparedness, Response, and Co-operation (OPRC), 1990
- The Montreal Protocol on Substances that deplete the Ozone Layer. Adopted on September 16, 1987
- Vienna Convention for the Protection of the Ozone Layer., 1985
- Protocol Concerning Cooperation in Combating Pollution in Cases of Emergency in the West and Central African Region, 1981
- Convention on the Conservation of Migratory Species of Wild Animals, 1979
- African Convention on the Conservation of Nature and Natural Resources, 1968
- RAMSAR Convention on conservation Wetlands 1971

An overview of these international conventions, protocols and agreements is provided in Chapter 1 of the ESIA.

4.4 INTERNATIONAL BEST PRACTICE STANDARDS AND GUIDELINES

The following IBP standards and guidelines are applicable to the Project and the requirements thereof have been considered in the development of this ESMMP:

- **Equator Principles** – the Equator Principles provide a set of 10 principles of voluntary standards that present a credit risk management framework for determining, assessing and managing social and environmental risk in Project financing. The Equator Principles are based on the IFC Performance Standards on social and environmental sustainability and on the World Bank Group EHS Guidelines. The Project has committed to complying with this set of principles, which together with the IFC Performance Standards and the EHS Guidelines will be used as a benchmark for IBP.

- **International Finance Corporation Performance Standards on E&S Sustainability, 2012 (IFC PSs)** – IFC's Sustainability Framework articulates the Corporation's strategic commitment to sustainable development and is an integral part of IFC's approach to risk management. The Sustainability Framework comprises IFC PSs and IFC's Access to Information Policy (2012).

  The Policy on E&S Sustainability describes IFC's commitments, roles, and responsibilities related to E&S sustainability. IFC's Access to Information Policy reflects the Agency's commitment to transparency and good governance on its operations and outlines IFC's institutional disclosure obligations regarding its investment and advisory services.

  The PSs are directed towards clients, providing guidance on how to identify risks and impacts, and are designed to help avoid, mitigate, and manage risks and impacts as a way of doing business in a sustainable way, including stakeholder engagement and disclosure obligations of the client in relation to Project-level activities.

  IFC requires its clients to apply the PSs to manage E&S risks and impacts so that development opportunities are enhanced.

  The PSs include:

  - PS 1: Assessment & Management of Environmental and Social Risks and Impacts.
  - PS 2. Labour and Working Conditions
  - PS 3. Resources Efficiency and Pollution Prevention
  - PS 4. Community, Health, Safety and Security
  - PS 5. Land Acquisition and Involuntary Resettlement
  - PS 6. Biodiversity Conservation and Sustainable Management of Living Natural Resources
  - PS 7. Indigenous Peoples
  - PS 8. Cultural Heritage

- **The World Bank Group (WBG) Environmental, Health and Safety (EHS) Guidelines** – the WBG EHS Guidelines (1991 and updated in 2007) are a set of technical reference materials that provide pollution related limits and standards. In general, the Guidelines seek to avoid, minimize and control EHS impacts during the construction, operation and decommissioning phase of a Project or facility, and are applicable to this Project. The EHS Guidelines serve as a technical reference source to support the implementation of the IFC PSs. Where applicable, the EHS Guidelines were considered in this ESIA process and in the development of this ESMMP.

- **Industry Specific WBG EHS Guidelines**: **Guideline for Ports, Harbors and Terminals**: The Ports, Harbors and Terminals Guidelines expands on the General EHS Guidelines and includes industry specific management guidance.

  This Guideline includes information relating to the environment (Air Emissions, Wastewater, Hazardous Materials, Waste management, Noise and Biodiversity), Occupational Health and Safety (Physical Hazards, Chemical Hazards, Confined Spaces, Exposure to Organic and

Inorganic Dust, and Exposure to Noise) and Community Health and Safety (Port Marine Safety, Port Security and Visual).

- **1.7.6 AfDB Integrated Safeguards Systems**: The AfDB's Integrated Safeguards System (ISS) is a set of policies, procedures, and guidelines established to identify, assess, and mitigate potential E&S risks and impacts associated with the Bank's funded projects and programs. The ISS were designed to ensure that the Bank's investments promote sustainable development and do not harm people or the environment. The updated ISS (April 2023) are comprised of the following:
  - AfDB's Vision for Sustainable Development
  - AfDB's E&S Policy
  - Ten E&S Operational Safeguards (OS)
  - E&S Guidance Notes (ISS Guidance notes)

  A list of the AfDB Safeguards is provided below:

  - E&S OS 1 (Assessment and Management of Environmental and Social Risks and Impacts)
  - E&S OS 2 (Labour and Working Conditions
  - E&S OS 3 (Resources Efficiency and Pollution Prevention and Management)
  - E&S OS 4 (Community Health, Safety and Security)
  - E&S OS 5 (Land Acquisition, Restrictions on Access to Land and Land Use, and Involuntary Resettlement)
  - E&S OS 6 (Habitat and Biodiversity Conservation & Sustainable Management of Living Natural Resources)
  - E&S OS 7 (Vulnerable Groups)
  - E&S OS 8 (Cultural Heritage)
  - E&S OS 9 (Financial Intermediaries (FIs))
  - E&S OS 10 (Stakeholder Engagement and Disclosure of Information)

4.5 PROJECT SPECIFIC EHS POLICIES AND STANDARDS

The following MM FZE EHS Policies and Standards have been considered in the ESIA process and this ESMMP:

- Non-Discriminatory Policy
- Child Labour Prohibition Policy
- Independent Contractors' Policy
- Gender Based Violence and Harassment Policy
- Anti-Retaliatory Policy
- Community and Stakeholder Policy
- Environment and Climate Change Policy
- Health and Safety Policy
- Human Rights and Labour Policy
- Product Stewardship and Treatment of Customer Policy
- Responsible Business Policy
- Social Media Policy

- Confidential Reporting Policy

5. KEY SENSITIVITIES

Key E&S sensitivities associated with the proposed MM FZE Project are summarised in Sections 5.1 to Section 5.3. These sensitivities have been used to provide contextual overview for defining the E&S management requirements in this ESMMP.

5.1 KEY PHYSICAL ENVIRONMENTAL SENSITIVITIES

- **Geology**: the geology underlying the Project Site mainly consists of unconsolidated sand. Due to its loose sandy nature, the geology can be classified as sensitive to impacts from dredging and installation of bored piles.
- **Soil:**
  - The soil on site is reclaimed with river sand, which dominates soil aggregates, making it friable both at wet and dry. The soils are sensitive to structure foundations.
  - Contamination from chemical and hydrocarbon spills on surface. Due to the relatively high permeability of the soil contamination can easily enter the soil and migrate away from the pollution source at a relatively high velocity, thereby further impacting the soils away from the pollution source.
  - Shallow excavations during construction of surface infrastructure can disturb the soil structure and increase soil erosion.
- **Groundwater:**
  - The groundwater in the Project area is associated with the unconsolidated sandy layers of the deltaic aquifer. The groundwater level is shallow at between 0 and 9 m depth. The aquifers are sensitive to potential contamination from surface water.
  - It is planned that two water supply wells will be installed, and it is estimated that 10m3/day will be used for potable water, and 10m3/day for service water. These volumes are relatively low and are not expected to have a notable impact on the overall groundwater availability in the sub-catchment. However, abstraction of groundwater from these water supply wells is expected lead to a drawdown in the groundwater level in the surrounding aquifers, which in turn may lead to saltwater intrusion from the Bonny Channel. Sodium and chloride concentrations in the Bonny Channel is measured to range around 3,500mg/L and 6,200mg/L respectively, while the sodium and chloride concentrations in the aquifers are measured to be in the order of 10 – 280mg/L and 20 – 700mg/L respectively. Saltwater intrusion into an aquifer is almost impossible to mitigate and can have an impact on surrounding groundwater users as well.
  - During the construction phase, heavy machinery will be operational on site. The spill can enter the soil and migrate vertically into the underlying aquifers from where it will migrate away from site. The extent and severity of these impacts are expected to be relatively low, but it is likely to remain in the soil and groundwater for a prolonged period. Remediation will be difficult.
- **Bonny River Channel:** the sub-catchment within which the site is located, is drained by the Bonny River, which forms the southern site boundary. The Bonny River is characterized by deep and shallow channels with semi diurnal tides that generate tidal current in phase with the tidal direction. The river is further characterized with strong currents, sandbars, and erosion. The Bonny River Channel is sensitive to saltwater intrusion caused by tidal currents.

- **Dredging:** The berth pocket in front of the quay where the vessel will be moored, will be dredged to a depth of approximately 13m. The dredging will temporarily increase turbulence and suspended solids in the water, but the longer-term impact will be on the river channel shape, which could impact the flow characteristics. However, it should be noted that the area where dredging will take place measures only around 450m and is a small percentage (<1%) of the total river channel area. The natural stream flow volumes are high with natural elevated suspended solids. There are also numerous other companies in the area that already do dredging / bed sweeping, therefore, the river sensitivity to the impacts is reduced.

5.2 KEY BIOPHYSICAL SENSITIVITIES

- **Terrestrial Biodiversity:** the Project area contains modified and sand-filled areas (dominated by grasses and sedges) covering most of the Project area, patches/relics of riparian mangrove vegetation along the quay-side, and secondary forest consisting of mangrove swamp vegetation (across the river body, about 2.3 km away from the proposed Project site). Despite indigenous species being present within habitats on and adjacent to the Project site, these are modified and under immense pressure from alien invasive plants.
- **Aquatic Biodiversity:** the estuarine biodiversity in the site has already been highly impacted, with mangroves largely removed. However, the site still has the potential to support important estuarine biodiversity, particularly on the intertidal mudflats. The Project will remove any remaining intertidal estuarine habitat on the limited area of the site., for which biodiversity offset in terms of the requirements of PS6 is advised.

5.3 KEY SOCIO-ECONOMIC SENSITIVITIES

- **Impacts on Natural Resource-based Livelihoods**: the communities in the Project area and surrounds rely heavily on agriculture and land use for their livelihoods. Any potential loss of environmental habitats or biodiversity loss will impact the surrounding communities negatively. Additionally, it was found that the surrounding communities also rely on fishing as a source of livelihood. Any impact to this during the construction and operation phase, such as increased pollution levels and water contamination, may result in impacts on natural resource-based community livelihoods.
- **Water Contamination**: surrounding communities rely on groundwater (boreholes and wells), as well as surrounding rivers and oceans as water sources. If any of these water sources become polluted, community livelihoods and household activities will be impacted.
- **Proximity of Communities to Site**: the construction phase could result in disruption to nearby communities to the north and north-west. The access to the site (roads and entrances) should be considered to minimise impacts to adjacent communities.
- **Construction Noise, Dust, Traffic:** such aspects must be managed to prevent impacts on nearby communities.
- **Changes in Local Air Quality:** mainly could negatively impact local communities, who are considered vulnerable due to their (assumed) low socio-economic status.
- **Site Access through Onne Community:** primary access to the site is along the main roads, including Ejaka-Wakanda Road, which runs through the center of the Onne community. Increased presence of heavy vehicles during construction, as well as trucks carrying urea for export during operation, may have an impact on traffic levels as well as the quality of local roads. Furthermore, the movement of heavy vehicles through a densely

populated town center presents several hazards such as traffic accidents or injuries or fatalities of pedestrians.

- **Reduced Community Cohesion and Access to Basic Services:** mainly due to influx of labour and outsiders during the construction phase.
- **Unmet Expectations**: for local employment, procurement, and socio-economic development.
- **Disruption to Fishing Livelihoods**: through environmental impacts and port traffic.
- **Community Health and Safety risks:** due to construction activities and security personnel.
- **Traffic:** existing levels of congestion on the East West Highway, which connects south-eastern Nigeria to Port Harcourt, are anticipated to increase due to increases in peak hour traffic, large vehicle traffic, and turning movements at the New Road Junction and Onne Road resulting from the MM FZE Project. Congestion on the route from the Port of Onne to the East West Road may increase due to increased truck traffic. Project-related vessel traffic will incrementally increase vessel congestion and risk of marine casualty events on the Bonny Channel.

6. IMPLEMENTATION OF THE ESMMP

6.1 OVERVIEW OF THE ESMMP

During the course of the ESIA process, Project design recommendations have been suggested, taking into account the need to avoid, minimise and reduce negative environmental, socio-economic and health impacts, and the opportunity to enhance positive impacts.

To ensure that identified and unforeseen or unidentified impacts are detected and resolved, a set of Environmental and Social Management Plans have been developed as an outcome of the ESIA (refer to Section 7).The Management Plans will be supplemented with additional requirements as detailed design proceeds prior to the commencement of the construction phase. Contractors and subcontractors will be required to develop their working methods and procedures having regard to these Management Plans.

The Management Plans are an integral part of the ESMS (refer to Section 3) and act as the main vehicle for converting the findings of the ESIA into action.

6.2 INSTITUTIONAL FRAMEWORK

6.2.1 FEDERAL MINISTRY OF ENVIRONMENT (FMENV)

As mentioned previously, FMEnv is the principal authority for the regulation and enforcement of environmental laws in Nigeria. The EIA Act established by the Ministry, which ensures that all development and industrial activities, operations and emissions are within the limits prescribed in the national guidelines and standards and comply with relevant regulations for environmental pollution management in Nigeria as and when these are released by the Ministry. Further to the Mandate, FMEnv developed laws/ guidelines on various sectors of the national economy including the Environmental Impact Assessment (EIA Act CAP E12, LFN 2004) Act and procedures for evaluating EIA reports. Furthermore, in September 2021, through Official Gazette No. 105, Vol 108, the Federal Republic of Nigeria published S.I. No. 109, Environment Impact Assessment Procedures and Charges Regulations. FMEnv consults with State Ministries of Environment and their Environmental Protection Agencies during the EIA permitting process.

6.2.2 NATIONAL ENVIRONMENTAL STANDARDS AND REGULATION ENFORCEMENT AGENCY (NESREA)

The National Environmental Standards and Regulations Enforcement Agency (NESREA) was established in 2007 by the Federal Government of Nigeria as an Agency of FMEnv. The Agency is charged with the responsibility of enforcing the environmental laws, guidelines, standards, and regulations in Nigeria, specifically during the operational phase of development Projects.

6.2.3 MELIORA METHANOL FEDERAL ZONE ENTERPRISE (MM FZE)

MM FZE, as the Project Proponent, have placed contractual obligations on the Contractor (with flow down requirements in relation to subcontractors), which have been considered in all Management Plans, and which need to be adhered to, and reported on, through the implementation of the ESMS.

6.2.4 CONTRACTORS AND SUBCONTRACTORS

MM FZE intends to engage the same Engineering, Procurement and Construction (EPC) Contractors that were engaged during the development of OIS Port for the Project. It is understood that where subcontractors will be engaged, subcontractors will be responsible for managing potential environmental, social, safety and health impacts of their contract activities. To this end, contractors and their associated subcontractors will need to:

- Demonstrate compliance with the EHS conditions, which apply under the contract;
- Demonstrate commitment to the ESIA and its Management Plans in their management structure;
- Identify individuals responsible for overall environment, social, safety and health management; and
- Undertake regular environmental, social, health and safety inspections and provide reports to allow for the monitoring and evaluation of performance.

During the construction phase, contractors and subcontractors will be key implementers of mitigation measures, as defined in Management Plans, and will also be responsible for compliance with the listed Performance Criteria (as provided in each Management Plan).

6.2.5 LENDERS TO THE PROJECT

In addition to in-country national laws and regulations, Lenders require that the Project applies specific health, safety, environmental and social standards which include, but are not limited to:

- Equator Principles (EPIV)
- IFC PSs
- WBG WHS Guidelines
- Industry Specific WBG EHS Guidelines – Port Operations

It is anticipated that the lenders will use in-house E&S expertise or independent consultants, to monitor the Project's performance against these standards, during all phases of the Project.

6.3 CONTINUED STAKEHOLDER ENGAGEMENT

MM FZE will continue to engage with stakeholders throughout the life of the Project. The objectives of ongoing stakeholder engagement are outlined in the separate Stakeholder Engagement Plan (SEP) and are to:

- Understand the interests, influence, and concerns of various Project stakeholders.
- Ensure effective, transparent, and timely communication between the Project and its stakeholders, to engender an environment of trust and mutual respect.
- Engage stakeholders on their concerns regarding the Project, and appropriately address these through dialogue and corrective actions.
- Establish effective means of communication to disseminate information from the Project to stakeholders.
- Design stakeholder engagement mechanisms and standards that respect local traditions and cultural norms.
- Effectively manage the expectations of stakeholders regarding socio-economic benefits derived from the Project.

- Establish the appropriate management mechanisms and identify necessary capacity building and training requirements for the effective implementation of the SEP.

The key principles guiding the Project's approach to stakeholder engagement are as follows:

- **Transparency:** to be open and transparent with stakeholders.
- **Accountability:** to be willing to accept responsibility as a corporate citizen and to account for impacts associated with the Project activities.
- **Trust:** to have a relationship with stakeholders that is based on mutual commitment to acting in good faith.
- **Mutual Respect:** to respect stakeholders' interests, opinions, and aspirations.
- Collaboration: to work cooperatively with stakeholders to find solutions that meet common interests.
- **Responsiveness:** to coherently respond in good time to stakeholders.
- Proactiveness: to act in anticipation of the need for information or potential issues.
- **Fairness:** to engage with stakeholders such that they feel they are treated fairly, and their issues and concerns are afforded fair consideration.
- **Accessibility:** to be within reach of stakeholders so that they feel heard and to provide meaningful information as needed.
- **Inclusivity:** to proactively anticipate, identify and include all stakeholders.

6.4 KEY COMPONENTS FOR IMPLEMENTATION OF THE ESMMP

6.4.1 TRAINING

One of the most important mechanisms for the enhancement of the Project's E&S performance will be the continued implementation of a training programme for all Project personnel including all subcontractors and third parties. The key components of training requirements are to ensure that all Project personnel, including all Contractors and Subcontractors and third parties understand the:

- E&S policies of MM FZE;
- E&S requirements of the Project and how these will be implemented and monitored on site;
- Contents and relevant requirements of Project actions contained within the applicable Management Plans;
- E&S sensitivities of the Project Footprint and surrounds;
- Procedures to be followed in the event of non-compliance with the E&S requirements;
- Process for addressing unforeseen E&S incidents; and
- Responsibilities with respect to E&S issues applicable to their roles.

Training should include:

- Induction training for all staff including modules on: health and safety, environmental awareness, worker code of conduct, stakeholder engagement, grievance mechanisms and cultural heritage awareness;
- Training on the EHS legal requirements and EHS compliance commitments of the Project. It is critical that all staff on the Project understand the laws and regulations and rules the Project has committed to, and that staff understand the consequences of breaking these rules;
- Toolbox training for specific topics and tasks; and

- Training for individuals involved in tasks with specific responsibilities.

Refresher training programmes will also need to be implemented to ensure continual improvement in environmental awareness for all Project personnel. Training should be provided at each stage of the Project, from the initial establishment of logistical facilities through to construction and (to a lesser degree) operation. The training function will assist managers in developing and coordinating training programmes as required. Training records should be maintained by the Project and an assessment of the effectiveness of the training.

6.4.2 EMERGENCY RESPONSE AND INCIDENT REPORTING

An Emergency Response Plan (ERP) must be in place for the Project, covering all incidents such as, but not limited to:

- Workplace accidents;
- Traffic accidents;
- Wildfires;
- Flooding;
- Hazardous materials spills and containment; and
- Community and/or Employee uprisings or strikes etc.

The Project should conduct drills on a periodic basis to test the planned response actions.

An incident is any occurrence that has caused, or has the potential to cause, a negative impact on people, the environment, property, or production (or a combination thereof). It also includes any significant deviation from standard operating procedures. The reporting and investigation of all potential and actual incidents that could have a detrimental impact on human health, the natural environment or property is required so that remedial and preventive steps can be taken to reduce the potential, or actual impacts, as a result of all such incidents. All incidents will be investigated for identification of causes and preventative actions. The actions resulting from any formal or informal investigations will be used to update the ERP.

6.4.3 AUDIT AND INSPECTION

An audit programme detailing the aspects to be audited, the area (relevant department or section), and the frequency of audits will be established. The audits will be based on appropriate protocols prepared by the various environmental, social and health and safety functions.

Regular environmental, social and health audits and random spot checks will be undertaken by selected audit team members throughout all phases of the Project. The audit and inspection frequencies will be defined and may be increased or decreased according to the audit findings and degree of confidence in the audit programme and will need to adapt to the Project work scope and locations, and Project activities (some of which will have higher risks). Audits will also assess compliance with agreed objectives and targets as well as the effectiveness of the management plans and their implementation.

Audit findings will be reviewed by the applicable management functions and where corrective actions are deemed necessary; the relevant management plans will be updated.

6.4.4 REPORTING

The Project should implement a system of internal reporting that allows for appropriate assessment of the effectiveness of the ESMS. Public reports should also be prepared on defined issues of interest or concern to local communities and /or stakeholders.

During the construction phase, contractors and associated subcontractors should take all appropriate measures detailed in the Project ESMS and related plans and procedures to identify and document incidents of environmental, social and health and safety non-conformance. Non-conformity reports should be produced at an appropriate frequency to ensure non-conformances are corrected. Non-conformity reports should identify the nature of the non-conformities and any subsequent actions taken and review the results or successes of any corrective actions taken. The resultant records should be reviewed in the appropriate management meetings so that required corrective actions can be taken, the results of any such corrective action can be recorded, and to increase management awareness of any opportunities for improvement.

These records are intended to facilitate the purposeful reduction of incidents of non-conformance, leading to a consequential reduction of the root causes of such incidents.

Chapter 8 presents the monitoring plan, which details parameters that should be monitored. The results from this data will be reviewed by MM FZE.

Annual reporting should be undertaken to review performance over the previous year and to set targets and objectives for subsequent years.

6.4.5 MANAGEMENT OF CHANGE

Even with a final design and an unchanging environment, impacts are difficult to predict with certainty. Uncertainty stemming from on-going development of the Project design is inevitable, and the social and biophysical environment is typically variable from season to season and year to year. Similarly, the organisational structure and roles and responsibilities may also change as the Project progresses. Where such uncertainties are material to ESIA findings, they should be clearly stated and conservatively approached (‘the precautionary approach’) to identify the broadest range of likely residual impacts and necessary mitigation measures.

The ESIA process does not stop with the submission of the Final ESIA report. Therefore, this ESMMP will require a mechanism to manage change. Changes will be assessed in terms of the severity to potentially alter the ESIA findings; i.e., those that result in adverse changes to the predicted significance of environmental and social impacts. Some changes may not result in a material change to the ESIA findings; however, in other instances, these changes may be material, potentially influencing the original findings of the ESIA, and hence, the basis for its approval. Such a mechanism to manage change, or a change management system, should ensure that changes to the scope of the proposed MM FZE Port Project are subjected to a robust social and environmental assessment process.

Any changes to Project scope or new substantive E&S findings through ongoing post-ESIA studies (as committed to in the ESIA) or monitoring should be evaluated for their degree of significance, and will be incorporated into the appropriate Project documentation as follows:

- Minor changes will be reflected in updates to the applicable Management Plans included in the overall ESMMP; and
- Substantive design changes that might potentially alter the ESIA findings should be subject to re-assessment, further stakeholder consultation, supplementary reporting, and revision

of the Project’s ESMMP. Typically, such substantive changes will be submitted as an addendum to this ESIA.

7. ENVIRONMENTAL AND SOCIAL MANAGEMENT PLANS

7.1 INTRODUCTION

The E&S Management Measures included in this ESMMP cover both construction and operation phases of the proposed MM FZE Port Project. The construction phase measures are primarily the responsibility of the Contractor, and MM FZE, although other parties, such as the Engineer, will also assume certain responsibilities in this regard.

Each management plan provides the following detail:

TABLE 7-1 MANAGEMENT PLAN STRUCTURE

Objective	**The management objective that applies to each aspect or impact.**
Timing and Frequency	During detailed Project design phase, the pre-construction (site establishment) phase, or construction phase of the Project.
Project Activity	Project related activities resulting in the impact.
Responsibility	The party responsible for implementing the management plan.
Performance Criteria	Measurable performance criteria (outcomes) for each element.
Mitigation Measures	The strategies, tasks, or action program (to nominated operational design standards) that will be implemented to achieve the performance criteria

PLEASE NOTE:

This ESMMP has been developed as a framework, which aims to address the specific impacts that are anticipated to occur as a result of the proposed MM FZE Port Project, and associated activities as identified in the ESIA and associated impact assessment. These management measures set out a formal system by which the Project can manage mitigation measures that will reduce impacts to the receiving physical, biological and social environments.

This ESMMP should be considered a “living” document and should be amended in light of the learning experienced during the implementation thereof.

This Chapter includes the following management measures:

Physical Environmental Management

- Air Quality
- Noise Management
- Geology and Soil
- Soil and Land use
- Groundwater
- Surface Water

Biological Management

- Estuarine and Aquatic Biodiversity

- Terrestrial Biodiversity

Social Management

- Socio-Economic
- Traffic
- Cultural Heritage

General Management

- Waste Management during Construction
- Spill Prevention, Control and Containment

7.2 PHYSICAL ENVIRONMENTAL MANAGEMENT PLANS

7.2.1 AIR QUALITY MANAGEMENT PLAN

7.2.1.1 OBJECTIVES

The overall objective for air quality management during the construction and operational phases is to manage emissions to the point that impacts are negligible, or at worst, minor. Furthermore, a key objective is to keep local communities and regulators informed of activities (where required) and to respond quickly and effectively to issues and complaints.

Construction and operational activities are to be conducted in a manner that manages impacts on ambient air quality such that emissions follow the Nigerian legislative and IFC requirements.

7.2.1.2 PROJECT ACTIVITIES RESULTING IN AIR QUALITY IMPACTS

Regarding the construction phase, there are potential impacts associated with emissions of dust arising from:

- Earthworks: there are earthworks >10,000m2, therefore the potential impacts are Large.
- Traffic on unpaved roads: there is no traffic on unpaved roads <25m from sensitive receptors, therefore the potential impacts are Small.
- Handling of dusty materials: there is the potential for activity on an area of >100,000m2, therefore the potential impacts are Large.
- Exposure of soil during site clearance and construction.
- Batching and mixing of cement, sand, and aggregates.
- Transport, handling, and stockpiling of friable materials required for construction.

During operational phase, is anticipated that air quality impacts from flaring will be Negligible.

7.2.1.3 RESPONSIBILITY

MM FZE, as Project owner, shall assume responsibility for ensuring the air quality management system throughout life of the Project. During construction, field implementation of the air quality controls will be managed and executed by the Contractor. Other parties, such as the Engineer, will also assume certain responsibilities in this regard which are detailed below.

7.2.1.4 PERFORMANCE CRITERIA

The primary performance criteria associated with air quality management for the proposed MM FZE Project include:

- Implement sufficient controls to cause no undue concerns expressed by surrounding stakeholders in terms of atmospheric emissions.

- Respond to all atmospheric emission related complaints received from surrounding stakeholders and implement mitigation measures.

With reference to the ESIA, both the relevant Nigerian and IFC standards and guidelines have been used. As such, the Project specific guidelines (which consider Nigerian ambient air quality standards and air quality guidelines from the WHO/IFC and EAE) are presented in Table 7-2.

TABLE 7-2 PROJECT SPECIFIC GUIDELINES

Pollutant	Averaging Period	Origin of Guideline	Value (µg/m³)
NO_2	Annual mean	IFC	40
	1 Hour Maximum	IFC	200
PM_{10}	Annual mean	Nigeria	60
	24 Hour	Nigeria	150
$PM_{2.5}$	Annual mean	Nigeria	20
	24 Hour Maximum	Nigeria	40
NH_3	Annual Mean	EAE	180
	1 Hour Maximum	EAE	2,500

7.2.1.5 MANAGEMENT MEASURES

The construction of the Project is not predicted to result in significant impacts. In terms of construction dust, with the correct implementation of the appropriate mitigation and management measures (refer to Table 7-3) residual impacts are considered to be Negligible or at worst Minor.

The operation of the proposed MM FZE Project is not predicted to result in air quality standards being exceeded in its own right. Given that the predicted impact magnitude for air quality impacts during the operational phases is anticipated to be Negligible, no further mitigation or design changes are proposed.

The management measures required for general construction related activities are included in Table 7-3.

TABLE 7-3 AIR QUALITY MANAGEMENT

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
Construction Dust Management				
1	Grievances	The Project will develop and implement a grievance procedure in the event of any dust complaints being received.	Start of construction	Grievance Procedure
2		All potentially impacted receptors will be informed of the nature of works to be carried out, the duration, as well as contact details for a Project representative that be contacted in the event of a complaint. All complaints will be managed as part of the Project's external feedback and grievance mechanism (mentioned above).	Throughout construction	Engagement records and grievance procedure
3		The Project will make efforts to prevent grievances by monitoring conditions and surroundings and taking action to prevent dust emissions off the Project site.	Throughout construction	
4	Vehicle Management	Impacts associated with construction road traffic during the construction phase will be mitigated by treating (dust suppression) unpaved road, to prevent or minimise dust emission from construction vehicles.	Throughout construction	Visual observations and dust complaints
5		Speed limits will be reasonably set on unpaved roads to minimise dust generation.	Throughout construction	
6		Work vehicles will be kept sufficiently clean to avoid tracking dirt around and off the site.	Throughout construction	
7		Work vehicles transporting friable materials will be kept adequately covered to prevent materials being spread around and off the site.	Throughout construction	
8		Where practically feasible and reasonable, vehicles that are compliant with recent emission standards (for example, EURO Tier 3) will be used. These vehicles will be maintained in reasonable working order. When not in use, vehicles will be switched off, unless impractical for health and safety reasons (for example maintenance of air conditioning).	Throughout construction	Vehicle inventory
9	Site Clearing and Earthworks	Where practical and feasible, surface binding agents will be used on exposed open earthworks (e.g., laydown yards).	Throughout construction	Visual observations and

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
10		The smallest possible area for cleared ground for work will be exposed, and where practical feasible, surface binding agents will be used on exposed open earthworks. Where the use of surface binding agents is not possible, the use of localised dampening and activity-specific dampening will be used to reduce localised emissions of dust.	Throughout construction	dust complaints
11	General	Drop heights of material will be minimised.	Throughout construction	Visual observations and dust complaints
12		Where feasible and necessary, windbreaks (perpendicular to the prevailing wind direction and at a height of approx. 0.5m) will be erected around active work sites.	Throughout construction	
		Management of Vehicle Emissions		
13	Vehicle Management	Vehicles will be regularly serviced (at least annually or in accordance with manufacturer's recommendations) and maintained in a reasonable working order to reduce emissions. Exhaust emissions should not emit black exhaust fumes or smoke.	Throughout construction	Maintenance records
14		When not in use, vehicles will be switched off, unless impractical for health and safety reasons (for example maintenance of air conditioning)	Throughout construction	Visual observations
15		Establish exclusion zones where the offloading of Project equipment / materials from trucks is not permitted.	Throughout construction	Visual observations
16	Diesel Type	Diesel fuel will be sourced from Indorama filling station or from a reputable supplier to fuel Project power driven machinery / vehicles / equipment.	Throughout construction	Records

7.2.2 NOISE MANAGEMENT PLAN

7.2.2.1 OBJECTIVES

The primary objective for noise management during the construction and operational phase of the Project is to minimise impacts on the closest and/or most affected noise sensitive receptors (NSR's) situated in the vicinity of the Project Area are minimised. Furthermore, a key objective is to keep local communities and regulators informed of activities (where required) and to respond quickly and effectively to issues and complaints.

7.2.2.2 PROJECT ACTIVITIES RESULTING IN NOISE IMPACTS

Construction activities will take place only during daytime hours, and therefore noise impacts during construction are anticipated to have negligible impact on NSRs in the proximity of the Project.

Noise emissions during typical operation are anticipated mostly from jetty operation, power generator plant, ammonia pump station, BOG, operation traffic, CNG, etc. Most of the operation equipment will be enclosed within structures and spread within a greater area, and therefore noise levels are likely not to exceed the relevant noise criteria.

Therefore, the predicted magnitude of airborne noise impacts during both construction and operations are anticipated to be negligible at NSRs in the immediate vicinity of the Project Area.

7.2.2.3 RESPONSIBILITY

MM FZE, as Project owner, shall assume responsibility for ensuring the noise management system throughout the life of the Project. During construction, field implementation of the noise controls will be managed and executed by the Contractor. Other parties, such as the Engineer, will also assume certain responsibilities in this regard which are detailed below.

7.2.2.4 PERFORMANCE CRITERIA

The primary performance criteria associated with noise management for the proposed MM FZE Port Project include:

- Implement sufficient controls to cause no undue concerns expressed by surrounding stakeholders in terms of noise emissions.
- Respond to all noise emission related complaints received from surrounding stakeholders and implement mitigation measures.

With reference to the ESIA, both the relevant Nigerian and IFC standards and guidelines have been used. As such, the Project specific guidelines are presented in Table 7-4. The daytime period will be based on the Nigerian criteria between 06:01 to 22:00 hours and the night-time period will be between 22:01 to 06:00 hours. The noise within the operational area shall be maximum 90dB(A) for day average as per FMEnv Guidelines. The other intermittent noise will be regulated as per national regulations.

TABLE 7-4 PROJECT NOISE CRITERIA FOR OPERATIONAL PHASE

Receptor	**One Hour L_{Aeq} (dB(A))**	
	Daytime (06:01 – 22:00)	Night (22:01 – 06:00)
Residential; institutional; educational	55	45

7.2.2.5 MANAGEMENT MEASURES

Given that the predicted impact magnitude for noise impacts during the construction and operational phases is anticipated to be Negligible, no further mitigation or design changes are proposed.

The management measures required for general construction related activities are included in Table 7-5.

TABLE 7-5 NOISE MANAGEMENT

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
1.	Grievances	The Project will develop and implement a grievance procedure that will address any noise complaints being received.	Start of construction	Grievance Procedure
2.		All potentially impacted receptors will be informed of the nature of works to be carried out, the duration, as well as contact details for a Project representative that be contacted in the event of a complaint. All complaints will be managed as part of the Projects external feedback and grievance mechanism (mentioned above).	Throughout construction	Engagement records and grievance procedure
3.		The Project will make efforts to prevent grievances by monitoring conditions and surroundings and taking action to prevent excessive noise emissions off the Project site.	Throughout construction	
4.	General	Where feasible and reasonable, the dropping of materials from height will be avoided.	Throughout construction	Records / visual observations
5.		Where practically feasible and reasonable, metal-to-metal contact on equipment will be avoided.	Throughout construction	
6.		Where needed and practically feasible, onsite chutes and bins will be lined with damping material.	Throughout construction	Visual observation
7.		Effective mufflers, enclosures and low-noise tool bits and blades will be selected, where necessary.	Throughout construction	Records
8.		The hours of operation for specific equipment or operations will consider community sensitivities (e.g., trucks or machines operating in or passing through community areas).	Throughout construction	Records / visual observations
9.	Vehicle and Machinery Management	Where feasible and reasonable, mobile plant parking near residences and other sensitive land uses will be prohibited. Moreover, exclusion zones where the offloading of Project equipment / materials from trucks is not permitted will be established.	Throughout construction	Records / visual observations
10.		Vehicles and equipment will be regularly inspected and maintained to ensure it is in good working order. The condition of mufflers will also be periodically	Throughout construction	Maintenance records

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
		checked.		
11.		Where feasible and reasonable, silencers or acoustic enclosures will be installed on stationary machinery. For example, procure equipment or install suitable mufflers on engine exhausts and compressor components as well as the use of portable sound barriers around equipment like generators.	Throughout construction	Records
12.		Where feasible and reasonable, alternatives to diesel and petrol engines and pneumatic units will be used (such as hydraulic or electric-controlled units).	Throughout construction	Equipment inventory
13.		Less annoying but equally safe alternatives to conventional audible reversing alarms will be considered (such as visual and/ or broadband noise emitting models i.e., 'squashed duck') that provide a safe system of work.	Throughout construction	Records / visual observations
14.		The unnecessary use of truck honking systems will be prohibited (especially when in or passing residential areas or schools) and will only be used to prevent vehicle / pedestrian collision.	Throughout construction	
15.		Where feasible and reasonable, equipment will be turned off when not being used.	Throughout construction	
16.		Where possible, Project traffic routing through community areas will be avoided and the implementation of speed limits for all construction vehicles shall be ensured	Throughout construction	
17.	Training	In addition to the above-mentioned management actions, training in noise control / occupational noise exposure control procedures will be provided to the relevant personnel.	Throughout construction	Training records

7.2.3 SOIL AND LAND USE MANAGEMENT PLAN

7.2.3.1 OBJECTIVES

Please note: As part of the Onne Port complex, which contains more than two hundred companies, the property is designated as an industrial area. The Onne Port Complex has been zoned as an industrial area for years and access is controlled. No land use change is discussed below because the land use was formally changed years ago.

The objectives of the soil and land use management plan are to:

- Reduce the impacts from bored piles installation.
- Reduce the impacts from dredging.
- Minimise impacts from surface infrastructure construction.
- Minimise the impacts from water supply well installation.
- Manage or minimise the impacts from increased vehicular activity.

7.2.3.2 PROJECT ACTIVITIES RESULTING IN GEOLOGY/SOIL IMPACTS

Pre-construction and construction phases

- Bored piles installation: Bored piles will be installed through the soft and loose granular geology. Installation will involve installation of steel liners, drilling under bentonite slurry, sand separation, placement of steel reinforced cage into the drilled hole, concrete casting, and other tasks. Drilling, installation of the steel cage, and concrete casting will impact the geology and the soils of the site by disturbance of the soil structure (compaction of surface soil by vehicles or loosening of the structure due to drilling).
- Construction of surface infrastructure: Surface infrastructure construction will mostly entail shallow excavation to establish foundations, which will have a moderate impact on the soils and land use of the site.
- Dredging: The berth pocket in front of the quay where the vessel will be moored, will be dredged to a depth of approximately 13 meters which will impact the geology and the soil in that area.
- Water supply well installation: It is planned that a total of 2 water supply wells will be installed. Drilling of the wells will have a localised impact on the geology, soils, and land use of the site.
- Vehicular activity on site: increased vehicular activity on site can impact the soil through compaction due to increased vehicular activity on unpaved areas, as well as hydrocarbon spills from vehicles which can contaminate the soil.

Operational phase

- Vehicular activity on site: increased vehicular activity on site can impact the soil through compaction due to increased vehicular activity on unpaved areas, as well as hydrocarbon spills from vehicles which can contaminate the soil.
- Dredging: The berth pocket in front of the quay where the vessel will be moored, will be dredged to a depth of approximately 13 meters. Dredging will be maintained over the life of operations in response to sediment deposition by the Bonny Channel refilling the dredged area to continue allowing ships to berth safely.

7.2.3.3 RESPONSIBILITY

- The ultimate responsibility for the implementation of management measures will lie with MM FZE. At all times, MM FZE will ensure sufficient capacity for the implementation of all management measures, as well as providing training to all staff and site visitors as may be required. Responsibilities of MM FZE will be extended by way of contract or other binding agreement to the construction company, operational staff as well as shipping agencies. During all Project phases, continued on-site oversight of implementation and compliance will be ensured by a suitably qualified Environmental personnel.
- The primary construction contractor will be responsible for implementation of mitigation and management measures during construction phase, whereas MM FZE will be responsible for implementation of mitigation and management measures during operational phase.
- MM FZE will remain responsible for the monitoring, evaluation, and oversight of contractor social performance for all phases of the Project.

7.2.3.4 PERFORMANCE CRITERIA

- Bored piles installation: Minimise the area where bored piles will be installed based on design by a competent person.
- Construction of surface infrastructure: Minimise excavations and restrict the footprint. Minimise the number of vehicles on site.
- Dredging: The area and depth to where dredging will take place will be minimised based on design by a competent agency . The area outside the designated dredge area that is included in the dredge envelope will be restricted to 30 m on either side.
- Water supply well installation:
  - Site the wells based on results from a ground geophysical survey to increase the likelihood of success in terms of the yield of the well, and therefore reduce the number of wells that will be required.
  - Reduced footprint of the drilling pads. Ideally restricted to 50 m radius from each well.
- Vehicular activity on site:
  - The number of vehicles on site, as well as their travel paths, are monitored and restricted to the minimum required in the execution of duties.
  - Regular, scheduled, maintenance of vehicles within designed areas and proper disposal of wastes (oil, cleaning fluids, used parts / spares, other contaminated material such as rags etc.).

7.2.3.5 MANAGEMENT MEASURES

The management measures included in Table 7-6 will be implemented to reduce soil impacts from the Project.

TABLE 7-6 SOIL IMPACT MANAGEMENT

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
1	Compaction of surface soil by vehicles, or loosening of the structure due to drilling during installation of bored piles.	• As far as possible, reduce the area where piles are to be installed based on design by competent agency. • As far as possible reduce the number of vehicles present on site.	Pre-construction and construction phases	• Minimisation of the area where piles are installed.
2	Disturbance of the soil structure due to shallow excavations, or compaction of the soil due to increased vehicular activity, during construction of the surface infrastructure.	• As far as possible reduce the footprint of the surface infrastructure. • As far as possible reduce the number of vehicles present on site.	Pre-construction and construction phases	• Reduce the footprint of the surface infrastructure. • Reduce the number of vehicles on site.
3	Disturbance of the soil during drilling of the water supply wells.	• Reduce the footprint of the well pads, ideally to 50 m radius around each well. • As far as possible reduce the number of vehicles present on site.	Pre-construction and construction phases	• Reduce the footprint of the drill pads. • Reduce the number of vehicles on site.
4	Compaction of soil, and contamination of soil, due to increased vehicular activity on site.	• Monitor and restrict the vehicular movement on site to that necessary for the execution of duties. • As far as possible reduce the number of vehicles present on site. • Perform vehicle maintenance in designated areas. • Dispose of oil, cleaning fluids, used parts / spares, other contaminated material such as rags to the appropriately approved waste disposal sites.	Pre-construction, construction, and operational phases	• Reduce the number of vehicles and their travel. • Proper vehicle maintenance and disposal of waste.

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
5	Dredging removing sand that form part of the geology and soil of the site.	• Impacts will be reduced by minimising the dredged area and the depth of dredging whilst still taking into consideration safe berthing of ships.	Pre-construction, construction, and operational phases	• Minimisation of the area where dredging is done. • Minimisation of the dredging depth.

7.2.4 GROUNDWATER MANAGEMENT PLAN

7.2.4.1 OBJECTIVES

The objectives of the Groundwater management Plan are to:

- Minimise impacts from groundwater abstraction on the surrounding aquifers. This includes a drawdown in groundwater level and reduction of the volume of available water in the surrounding aquifers, as well as saltwater intrusion from the Bonny Channel.
- Minimise impacts from the installation of bored piles on groundwater flow patterns.
- Minimise or prevent impacts on the groundwater quality from sources such as chemical and hydrocarbons spills, the use of sea water for fire water, and sewage management and disposal.

7.2.4.1 PROJECT ACTIVITIES RESULTING IN GROUNDWATER IMPACTS

The Project activities that can result in groundwater impacts during the pre-construction and construction, and operational phases are summarised below:

Pre-construction and Construction Phases

- Groundwater Abstraction: It is planned that two water supply wells will be installed. The abstracted groundwater will be stored in a storage tank of suitable capacity, from where the water will be supplied to the point of use. It is estimated that 10 m3/day will be used for potable water, and 10 m3/day for service water.
- Bored Piles Installation: Bored piles will be installed through the soft and loose granular geology. Installation will involve installation of steel liners, drilling under bentonite slurry, sand separation, placement of steel reinforced cage into the drilled hole, concrete casting, and other tasks Stabilising muds, consisting of bentonite and water will be used. Drilling, installation of the steel cage, and concrete casting can impact the groundwater flow patterns. The source of water for the slurry and concrete casting is not known, and it is assumed that it will be sourced from the water supply wells on site, which could lead to saltwater intrusion into the aquifers.
- Chemical and Hydrocarbon Spills: During the construction phase, heavy machinery will be operational on site. There is a risk of impacts to the groundwater quality through accidental spills of fuels and oils, as well as other contaminants related to the transportation of equipment and materials during the construction phase. The spill can enter the soil and migrate vertically into the underlying aquifers from where it will migrate away from site.

Operational phase

The sources of impacts during the operational phase can include:

- Groundwater abstraction: It is planned that two water supply wells will be installed. The abstracted groundwater will be stored in a storage tank of suitable capacity, from where the water will be supplied to the point of use. It is estimated that 10 m3/day will be used for potable water, and 10 m3/day for service water. Abstraction of groundwater can lead to saltwater intrusion into the aquifers.
- Chemicals and Hydrocarbon Spills: during the operational phase there is a risk of impacts to water quality through accidental spills of fuels and oils, as well as other contaminants

related to the transportation of equipment and materials. Potential sources of contaminants include:

- Urea produced at the manufacturing site will be transported to the Terminal

  through covered tipper trucks having 40 MT payload capacity. Urea will be unloaded from the trucks. The unloaded urea passes through a grizzly (screen) and falls into underground hopper. The hopper bottom is fitted with belt conveyor through which the urea is conveyed to a bucket elevator. The bucket elevator conveys the urea to another belt conveyor at the top of urea warehouse. During transport, unloading of the transport trucks, and conveying accidental spills could occur, which could impact the groundwater resource quality.

- Ammonia produced at the manufacturing site will be transported to the Terminal

  by means of dedicated tankers. The ammonia will be unloaded & stored in an Ammonia Storage Tank for export. The design of ammonia Storage tank will be undertaken considering storage of ammonia at atmospheric pressure in refrigerated conditions. Accordingly, the tank will be double walled with inner insulation on outer wall, suspended deck with construction complying with latest edition of applicable standards. The storage tank will have all necessary instrumentation, Pressure Safety Valves (connected to Flare) and controls, over pressure and vacuum protection systems as applicable in accordance with SIL ratings. The liquid Ammonia from the storage tank will be transferred to the ship for export. A pumping station with interconnecting piping, requisite instrumentation and safety systems will be installed. This is not seen to pose a significant risk of contamination to the groundwater resource.

- The bulk urea will be loaded into the vessel by means of a travelling Ship-loader

  mounted on rails. The Ship-loader consists of a rail mounted travelling tripper-car housed in the quay conveyor which feeds the urea to a series of conveyors and a cascade chute through which urea gets loaded into the different hatches of the vessel without causing any damage to the urea granules. This is not seen to pose a significant risk of contamination to the groundwater resource.

- Sea water will be used for the fire water requirement of the terminal. Fire water pump house will be constructed near the shoreline. Sea water will be pumped from the fire water pumping station and distributed within the terminal area through underground / aboveground fire water piping network. Use of the seawater during firefighting could impact the groundwater qualities in the underlying aquifers should excessive volumes of used seawater pond on surface and eventually recharge into the soils.
- The sewage generated in the entire terminal area will be appropriately treated before discharging it outside of premises. A package sewage treatment unit of suitable size will be considered for treatment and disposal. With proper design and maintenance this is not seen to pose a significant risk of contamination to the groundwater resource.

7.2.4.2 RESPONSIBILITY

MM FZE, as Project owner, shall assume responsibility for ensuring the groundwater management system throughout the life of the Project. During construction, field implementation of groundwater controls will be managed and executed by the Contractor. Other parties, such as the Engineer, will also assume certain responsibilities in this regard which are detailed below.

7.2.4.3 PERFORMANCE CRITERIA

- **Groundwater Abstraction:** groundwater abstraction from each water supply well will be managed to minimise the vertical drawdown of the groundwater level within each well. The performance criterium is to limit the zone of influence of the groundwater level drawdown cone around each of the water supply wells so that it does not intercept the Bonny Channel, or existing water supply wells on neighboring properties.
- **Impacts from Bored Piles Installation**: monitoring the impact from installation and presence of the bored piles can be done by installing a number of monitoring wells where groundwater levels can be measured, tracer tests being done to characterise changes in groundwater flow patterns due to the piles blocking flow and measuring baseflow contribution to the Bonny Channel. Based on the cost associated with installing the required number of monitoring wells, and the high flow volume of the Bonny Channel in comparison to the potential reduction in stream flow volume that might be caused by the piles reducing baseflow contribution, it is considered impractical to monitor this effectively. No performance criteria can be set.
- Impacts from Chemicals and Hydrocarbons:
  - Minimise the occurrence of spills.
  - Minimise the contact area and time with the soil.
  - Review management practices and adapt to address and shortcomings.
  - The groundwater contaminant indicators nitrate (NO3), and ammonia (NH3) to comply with the relevant water quality guidelines. Where elements exceed the quality guidelines, or where increasing trends are identified, management and mitigation will be revisited. Relevant water quality guidelines include:
    - IFC Guidelines on effluent levels for nitrogenous fertilizers manufacturing plants (International Finance Corporation, 30 April 2007).
    - Nigerian Standard for Drinking Water Quality (Standards Organisation of Nigeria, 2015).
- Impacts from Saltwater used for Fire Water:
  - Prevent an increase in sodium and chloride concentrations in the groundwater following the use of saltwater as fire water. In the case where the concentrations do increase, then the concentrations are to be managed to remain below the water quality guidelines specified in the Nigerian Standard for Drinking Water Quality (Standards Organisation of Nigeria, 2015). The guideline limits are 200 mg/L for sodium, and 250 mg/L for chloride.
- Impacts from Sewage:
  - Prevent the occurrence, or an increase in concentrations, of the indicators in the groundwater quality. In the case where the concentrations do increase, then the concentrations will be managed to remain below the water quality guidelines specified in the Nigerian Standard for Drinking Water Quality (Standards Organisation of Nigeria, 2015). The guideline limits are 10 cfu/mL for total coliform count, and 0 cfu/mL for E. Coli, as well as Enterococcus and Streptococcus spp.

7.2.4.4 MANAGEMENT MEASURES

The management measures included in Table 7-7 will be implemented to reduce groundwater impacts from the Project.

TABLE 7-7 GROUNDWATER IMPACT MANAGEMENT

<table>
<tr><th></th><th>Aspect Activity</th><th>Management Measure</th><th>Timing and Frequency</th><th>Target / Performance Indicator</th></tr>
<tr><td></td><td>Grievances</td><td>The Project will develop and implement a grievance procedure in the event of any water complaints being received.</td><td>Start of construction.</td><td>Grievance Procedure</td></tr>
<tr><td>1</td><td>Groundwater Abstraction from Groundwater Supply Wells.</td><td>The groundwater abstraction from each water supply well will be managed to minimise the vertical drawdown of the groundwater level within each well. The aim is to prevent the zone of influence of the groundwater level drawdown cone from reaching the Bonny Channel, or any other existing water supply wells on neighbouring properties.
The sustainable yield of each of the water supply wells will be determined from aquifer test results. The aquifer tests will be done in compliance with IBP guidelines and include at least:
Calibration / step test which entail at least 3 x 1-hour steps on increasing yield followed by recovery at the end of the 3 steps. The groundwater level depth will be monitored at a regular interval, preferably with a continuously (30 second interval) measuring level logger.
A 24-hour constant rate test during which a constant volume of wate will be pumped from the well. The pumping rate will be determined from the calibration / step test phase. The groundwater level will be monitored at a regular interval, preferably with a continuously (30 second interval) measuring level logger.
Recovery of the groundwater level in the well will be measured after completion of the 24-hour constant rate pumping phase. The recovery of the groundwater level will be monitored until 90% recovery is reached, or 24 hours, whichever comes first.
A pumping schedule will be designed that aims to supply the required water volume, but also that minimises the groundwater level drawdown in each of the wells. Preferably, the wells will not be pumped continuously for 24 hours per day, 7 days per week. Rather, a schedule will be developed where the groundwater level will be allowed to recover to natural, or near natural level, before pumping resumes. Allowing the groundwater level to recover in the well will minimise the extent of the</td><td>Pre-construction, Construction, and operational phase

Monthly groundwater monitoring during construction phase and quarterly monitoring during operation phase.</td><td>Monitoring of groundwater level.
Monitoring of groundwater quality for sodium and chloride.</td></tr>
</table>

	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
		drawdown cone, which in turn will minimise the possibility of salt water being drawn from the Bonny Channel towards the water supply wells and the resultant impact of saltwater intrusion on the aquifers. This schedule will be developed by a qualified hydrogeologist. • The water supply wells will be located as far as possible from the Bonny Channel, as well as other existing water supply wells on neighbouring properties, in order to reduce the possibility of saltwater intrusion from the Bonny Channel. • Groundwater monitoring wells can be installed close to the river, in the area between the water supply wells and the Bonny Channel, to monitor changes in groundwater level, and sodium and chloride concentrations. Sodium and chloride will act as indicators of saltwater intrusion from the Bonny Channel into the aquifers. • A groundwater monitoring program should be implemented prior to the construction phase to monitor any potential construction and operational related impacts.		
2	Installation of bored piles disrupting groundwater flow patterns.	• The impact on flow patterns will be minimized by minimizing the area covered by the installed piles.	Construction phase	• Ensure area where piles are installed is minimised
3	Contamination of the aquifers from chemical and hydrocarbon spills.	• Implementation of the Spill Prevention, Control and Containment Management Plan (refer to Section 7.5.2). • All construction and operational areas and associated facilities will be maintained in a good and tidy condition. This will include bunding of vehicle parking areas, oil and silt traps in the workshop area and proper disposal of waste material. • Chemicals used on site must be stored in a properly constructed area, with sealed floor, roofing, and walls where applicable, and access control. Waste chemicals will be disposed of at a suitable landfill site or by approved waste management facility. • Minimise the occurrence of spills. Annual reports will be compiled and trends in the frequency and severity of the spills will be identified. In the case where there are increasing trends, measures will be put in place to reduce the trends. • In the case of spills occurring the volume of the spill, the area affected, the contact time with the soil will be minimised. Infrastructure failures leading to spills to be repaired immediately where possible, or in the	Ongoing through the construction and operational phase Monthly groundwater monitoring during construction phase and quarterly monitoring during operation phase.	• Annual reporting detailing number of spills, spill area, time to remediate. • Monitoring of groundwater quality for nitrate (NO_3), and ammonia (NH_3). Ensure groundwater qualities remain compliant with regards to

	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
		shortest practicable timeframe. • In the case where non-adherence to management practice, or the absence / inadequacy of management practices, lead to spills, responsible persons will be identified, and/or management practices will be adapted to address and shortcomings. • A groundwater quality monitoring program will be implemented to monitor the groundwater quality for indications of contamination originating from the transport, off-loading, handling, storage, and loading for export, of urea and ammonia. The groundwater quality will be analysed for the presence of contaminant indicators, increasing trends in the indicator parameters, and compared to the relevant water quality standards. Where elements exceed the quality guidelines, or where increasing trends are identified, management and mitigation will be implements. The quality guidelines include: ° WBG Guidelines on effluent levels for nitrogenous fertilizers manufacturing plants. ° Nigerian Standard for Drinking Water Quality (Standards Organisation of Nigeria, 2015). Contaminant indicators include nitrate ($NO_3$and ammonia (NH_3).		legislation.
4	Impacts from saltwater used for fire water	• A groundwater quality monitoring program will be implemented to monitor the groundwater quality for indications of contamination originating from the use of saltwater that is taken from the Bonny Channel, as fire water. • Indicators for saltwater contamination, which include sodium (Na) and chloride (Cl), will be monitored. • Water quality will be compared to guidelines specified in the Nigerian Standard for Drinking Water Quality (Standards Organisation of Nigeria, 2015). The guideline limits are 200 mg/L for sodium and 250 mg/L for chloride. • In the case where the concentrations increase, then management system are to be put in place to prevent further increase. This could include using other sources of water with lower sodium and chloride concentrations. • Note, the sodium and chloride concentrations in the aquifers are currently measured to be in the order of 10 – 280 mg/L and 20 – 700 mg/L respectively. These concentrations are near the water quality guidelines. It could be necessary to apply for exemption, or relaxation, for any regulatory permit required.	Pre-construction, Construction and operational phase. Monthly groundwater monitoring during construction phase and quarterly monitoring during operation phase.	• Monitoring of groundwater quality for sodium and chloride. Ensure groundwater qualities remain compliant with regards to legislation.

	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
5	Impacts from sewage	• A groundwater quality monitoring program will be implemented to monitor the groundwater resource for indications of contamination originating from the sewage infrastructure. Indicators for sewage contamination include faecal indicator bacteria, including coliform bacteria, Escherichia coli (E.Coli), Enterococcus and Streptococcus spp. • In the case where the concentrations do increase, then the concentrations are to be managed to remain below the water quality guidelines specified in the Nigerian Standard for Drinking Water Quality (Standards Organisation of Nigeria, 2015).	Pre-construction, Construction and operational phase. Monthly groundwater monitoring during construction phase and quarterly monitoring during operation phase.	• Monitoring of groundwater quality for coliform bacteria, Escherichia coli (E.Coli), Enterococcus and Streptococcus spp. Ensure groundwater qualities remain compliant with regards to legislation.

7.2.5 SURFACE WATER MANAGEMENT PLAN

7.2.5.1 OBJECTIVES

The objectives of the Surface Water Management Plan are to:

- Minimise the impacts from dredging of the berth pocket in front of the quay on the stream flow characteristics and sediment load.
- Reduce the impact from the construction of surface infrastructure on the stream flow volumes and sediment load.
- Minimise or prevent the impact from groundwater abstraction through water supply wells on the stream flow volume.
- Manage the impact from increased vehicular movement on surface water quality.
- Reduce or minimise the impact on the Bonny Channel by marine vessels that use the river for export of urea and ammonia products.
- Reduce the impacts on flood risk.

7.2.5.2 PROJECT ACTIVITIES RESULTING IN SURFACE WATER AND SEDIMENTS

The Project activities that can result in surface water impacts during the pre-construction and construction, and operational phases are summarized below.

Pre-construction and Construction Phases

Sources of impacts to the surface water resource during the construction phase include:

- Dredging: The berth pocket in front of the quay where the vessel will be moored, will be dredged to a depth of approximately 13 meters.
- Construction of Surface Infrastructure:
  - Surface infrastructure construction will lead to increased paved and roofed area, which will increase surface runoff during rainfall events and subsequently an increase in river flow volumes.
  - Construction activities can result in silt laden surface water runoff that impact the river water quality.
- Water Supply Well Installation and Groundwater Abstraction: It is planned that a total of two water supply wells will be installed. Relatively small volumes of groundwater will be abstracted from these wells. Should the zone of influence of the groundwater level drawdown cone that develop around each of the wells reach the Bonny Channel, then some small quantities of stream water can be drawn towards the wells.
- Increased Vehicular Movements: Vehicle movements could decrease the quality of surface water runoff due to tyre wear particles, chemicals used in oils and lubricants, and spillage of fuels.
- Impacts on Flood Risk can originate from:
  - Earthworks required to facilitate the Project, which will alter the topography of the local area. Any depressions created could facilitate stagnant pools of water following periods of heavy rainfall.

- Paving of the road surface, which will increase surface water runoff rates and velocities.
- . This has potential to negatively impact hydrologically connected

  downstream watercourses, and sensitive receptors immediately adjacent to the property.

Operational phase

Sources of impacts to the surface water resource during the operations phase include:

- **Dredging:** The berth pocket in front of the quay where the vessel will be moored, will be dredged to a depth of approximately 13 meters. The dredging will be maintained at an intermittent interval as required until the end of life of operations.
- **Water Supply Well Abstraction:** It is planned that a total of two water supply wells will be installed. Relatively small volumes of groundwater will be abstracted from these wells. Should the zone of influence of the groundwater level drawdown cone that develop around each of the wells reach the Bonny Channel, then some small quantities of stream water can be drawn towards the wells.
- **Increased Vehicular Movements:** increased movements could decrease the quality of surface water runoff due to tyre wear particles, chemicals used in oils and lubricants, and spillage of fuels.
- **Use of the Bonny Channel by Marine Vessels:** Vessels are required for export of the urea and ammonia products: Marine vessels will traverse the river and berth at the quay for export of the urea and ammonia products. Marine vessels can impact the surface water quality through spills of fuel, oils, paints, and cleansers.

7.2.5.3 RESPONSIBILITY

MM FZE, as Project owner, shall assume responsibility for ensuring the groundwater management system throughout the life of the Project. During construction, field implementation of surface water controls will be managed and executed by the Contractor. Other parties, such as the Engineer, will also assume certain responsibilities in this regard which are detailed below.

7.2.5.4 PERFORMANCE CRITERIA

- **Dredging:**
  - The change in stream flow velocity downstream compared to the stream flow velocity upstream of the quay will be less than 2 %.
  - The increase in suspended solid load in the river water will be less than 1% during dredging.
- **Construction of Surface Infrastructure:**
  - Stream flow volume will not increase more than 1 %.
  - The increase in suspended solid load in the river water will be less than 1% during construction.
- **Groundwater Abstraction:** The zone of influence of the groundwater level drawdown cone will be managed such that:
  - It does not reach the river.
  - In the case that the zone of influence does reach the river, then the reduction in stream

flow volume is less than 1 %.

- **Increased Vehicular Movement:** surface water quality will be monitored. Indicators of contamination from vehicles, which include hydrocarbon, will not increase by more than 1 %.
- **Use of the Bonny Channel by Marine Vessels for Export of the Urea and Ammonia Products:** Surface water quality will be monitored. Indicators of contamination from marine vessels, which include hydrocarbon (fuel, oils, etc.) and other waste will not increase by more than 1 %.
- **Flood Risk:** the change in stream flow velocity downstream compared to the stream flow velocity upstream of the quay will be less than 2 %.

7.2.5.5 MANAGEMENT MEASURES

The management measures included in Table 7-8 will be implemented to reduce surface water impacts from the Project.

TABLE 7-8 SURFACE WATER IMPACT MANAGEMENT

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
	Grievances	• The Project will develop and implement a grievance procedure in the event of any water complaints being received.	Start of construction.	• Grievance Procedure
1	Dredging changing the river channel and flow characteristics.	• The impact can be reduced by minimising the dredged area and the depth of dredging whilst still taking into consideration safe berthing of ships.	Pre-construction, construction, and operational phases.	• Optimised design of dredge area and depth by competent agency. • Monitoring of surface water suspended solids load upstream and downstream of quay. • Monitoring of stream flow velocity.
2	Construction of surface infrastructure increasing surface runoff into the river, impacting stream flow volumes and suspended solid load.	• Reduce the footprint of infrastructure built, and paving installed, on site. • Install stormwater management infrastructure such as culverts, storm water diversion channels etc.	Pre-construction and construction phases.	• Optimised design of surface infrastructure and stormwater management infrastructure by competent person.
3	Groundwater abstraction reducing baseflow contribution to the river, or actively drawing water from the stream.	The groundwater abstraction from each water supply well will be managed to minimise the vertical drawdown of the groundwater level within each well. The aim is to prevent the zone of influence of the groundwater level drawdown cone from reaching the Bonny Channel, or any other existing water supply wells on neighbouring properties. Implementation of the management measures included in the Groundwater Management Plan (Section 7.2.4) under the Aspect – "Groundwater Abstraction from Groundwater Supply Wells".	Pre-construction, Construction, and operational phase Monthly groundwater monitoring during construction phase and quarterly monitoring during	• The zone of influence of the groundwater level drawdown cone does not reach the Bonny Channel. This can be monitored through a monitoring well installed close to the river, in the area

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
			operation phase.	between the water supply wells and the Bonny Channel.
4	Vehicle Management	• The washing of Project vehicles in any surface water bodies in and around the Project Area will be prohibited. All Project vehicles will be washed at designated wash bays on site. These wash bays will include oil/grease and sediment traps for grey water. • The maintenance of vehicles in and around the Project Area will as far as possible be avoided. Major planned maintenance will be performed at a designated workshop. The workshop will include containment and an oil/grease trap.	Throughout construction	Visual observations and records
	Spillages of Chemicals and Contaminants during Construction and Operation	• All construction and operational areas and associated facilities will be maintained in a good and tidy condition. This will include bunding of vehicle parking areas, oil and silt traps in the workshop area and proper disposal of waste material. • Chemicals used on site must be stored in a properly constructed area, with sealed floor, roofing, and walls where applicable, and access control. Waste chemicals will be disposed of at a suitable landfill site or at an approved waste management facility. • A surface water monitoring program should be implemented prior to the construction phase to monitor any potential construction and operational related impacts.	Ongoing throughout the operation. Monthly surface water monitoring at the sites included in the baseline study, during construction and operation phases.	• Ensure surface water qualities remain statistically similar to baseline
	Dewatering of Construction Sites	• Stormwater management of the construction site will be planned in advance and implemented to separate clean and dirty water systems to avoid the transport of contaminants and sedimentation into aquatic systems.	Throughout construction	• Detailed project planning designs • Site audit reports
	Wastewater	• Sufficient temporary toilets will be located in strategic locations near active work sites during the construction phase and sited away from any water bodies. These toilets will have doors and locks and will be secured to prevent them blowing over. Temporary toilets will be serviced regularly by a competent and suitably qualified person. Emptied waste will be transported and suitably disposed of.	Throughout construction	• Visual observations and records

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
5	Use of the Bonny Channel by marine vessels for export of the urea and ammonia products.	• Where possible, (i.e., through the use of vessels with a larger carrying capacity) minimise the number of vessels. • Minimise the time that vessels spend at the berth. • Monitor waste or accidental spills.	Operational phase	• Annual report detailing the number of vessels and time spent at berth. • Operators to report on waste or accidental spills released into the Bonny Channel.
6	Increase in flood risk due to site activities and surface infrastructure changing flood characteristics	• Manage the earthworks to control surface slope. • The footprints for all infrastructure should (where possible) be restricted to the minimum feasible extent with measures implemented to roof and paved areas. • Install stormwater management infrastructure such a berms and culverts.	Pre-construction, construction, and operational phases.	• Optimised design of surface infrastructure and stormwater management infrastructure by competent agency.

7.3 BIOLOGICAL MANAGEMENT PLANS

7.3.1 ESTUARINE AND AQUATIC BIODIVERSITY MANAGEMENT PLAN

7.3.1.1 OBJECTIVES

The objectives of estuarine and aquatic biodiversity management plan are to ensure impacts of the Project on the estuarine biodiversity remain in conformance with applicable standards and performance targets, to implement mitigation measures such that impacts are ameliorated to the extent predicted or an acceptable level, and to identify additional mitigation or management measures required to further ameliorate Project impacts.

7.3.1.2 PROJECT ACTIVITIES RESULTING IN AQUATIC BIODIVERSITY IMPACTS

The following types of potential impacts are considered during the construction phase:

- Direct loss of estuarine habitat and biota within the development footprint.
- Impacts of dredging, including increased turbidity, resuspension of pollutants, changes to the sediment profile, and impacts to estuarine habitat and biota downstream of the development.
- Disturbance to avifauna.
- Impacts of construction noise on estuarine biota.
- Changes in stormwater runoff.
- Changes in estuarine form and function.

The following types of direct impacts are considered during the operational phase:

- Impacts of light on estuarine biota.
- Disturbance of avifauna.
- Impacts associated with increased vessel traffic, including the impacts of underwater noise on estuarine biota.
- Impacts of routine discharges from vessels.

7.3.1.3 RESPONSIBILITY

MM FZE, as Project owner, shall assume responsibility for ensuring the estuarine and aquatic biodiversity management system throughout the life of the Project. During construction, field implementation will be managed and executed by the Contractor. Other parties, such as the Engineer, will also assume certain responsibilities in this regard which are detailed below.

7.3.1.4 PERFORMANCE CRITERIA

According to IFC PS6, the loss of natural habitats is discouraged and requires that any impacts to natural habitats are associated with No Net Loss of Biodiversity. In the case of this Project, this can be achieved through avoidance of sensitive features, minimisation of impacts, and rehabilitation.

7.3.1.5 MANAGEMENT MEASURES

The management measures included in Table 7-9 will be implemented to reduce Estuarine and Aquatic Biodiversity impacts from the Project.

TABLE 7-9 AQUATIC BIODIVERSITY IMPACTS MANAGEMENT

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
1	Project construction	• The final Environmental Management and Control Plan, will include procedures for a suitable biodiversity offset strategy that meets the requirements of PS6. This strategy will be developed by qualified personnel. This offset strategy will be developed in partnership with local NGO's active in preserving mangrove systems in the broader Project area and could include: o Expansion of existing protected mangrove systems. o Improved management or habitat enhancement of existing protected mangrove systems. o Financial support to existing mangrove conservation funds.	Starting prior to construction and adapted and implemented during construction.	An environmental management and control plan is implemented
2	Fuel and ammonia & Urea product spills	• Refer to the Spill Prevention, Control and Containment Management Plan included in Section 7.5.2.	Throughout construction and operations	A Spill Prevention and Management Plan is implemented.
5	General pollution such as litter	• Refer to the Waste Management Plan included in Section 7.5.1.	Throughout construction and operations. Annual staff training on waste disposal.	A Waste Disposal and Management Plan is implemented. All waste is correctly disposed of and does not enter the estuarine environment.
6	Catastrophic loss of containment	• An Emergency Plan will be developed and implemented, including monitoring activities.	Implemented throughout construction and operations.	An Emergency Plan is implemented.

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
7	General impacts on estuarine habitats and biota	• All Project staff and contractors working on site will undergo Environmental Induction, in which they are informed and educated about sensitive estuarine habitats and species, how to reduce and avoid impacts on the environment, the need for careful handling and management of chemical substances, how to dispose of waste, and what to do should an impact occur e.g., a fuel spill, littering, etc.	Prior to construction, during construction, and during operations. Occurring once per person.	All staff and contractors working on site receive Environmental Induction before commencing work.
8	Removal of estuarine habitat, including mangroves	• The development of an offset strategy that meets the requirements of PS6 (refer to Reference no. 1 in this table). • Areas of bare ground resulting from the proposed construction activities will be appropriately revegetated.	During construction, continuing for lifetime of Project.	A developed and implemented offset strategy for the Project that conforms to the requirements of PS6.
9	Disturbance of remaining estuarine habitat	• Construction equipment will be contained to within the development footprint to avoid disturbance of the estuarine environment and sediment outside of this area.	Daily during construction	Disturbance of estuarine habitat outside of the construction footprint is minimal.
10	Impacts on estuarine biota due to discharges from vessels	• Ballast water and sewage from vessels will be treated appropriately before discharge.	During construction and operational phase; whenever waste or ballast is to be disposed.	Ballast water and sewage from vessels is treated before discharge.
11	Increased noise levels	• An Underwater Noise Survey will be undertaken to determine baseline underwater	Prior to	An

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
	due to Project vessels	noise levels in the estuary and in the vicinity of the Project, as well as the increased noise levels once construction and operations commence, to inform adaptive management of underwater noise. • A speed limit will be enforced for Project related vessels transiting the estuary, to reduce noise levels. This speed limit will be informed by the Underwater Noise survey and international standards. • Vessels will maintain a buffer of 200 m from waterbirds.	construction, during construction and during operations.	Underwater Noise Survey is undertaken before, during and after construction. Based on the findings of this survey, the impacts of noise on estuarine biota are reduced.
12	Increased underwater noise due to construction	• Equipment will be maintained in good working order. • “Soft starts” will be employed to reduce the startle response of receptors. • Noise reduction techniques will be employed, such as the use of bubble curtains while pile driving. • A Marine Mammal Observer (MMO) will be appointed to survey for aquatic mammals during piling operations and other loud underwater construction. • Should the MMO sight an aquatic mammal, underwater construction will be paused until the animal has left the area.	During construction, daily.	The impacts of construction noise on estuarine biota are reduced.
13	Dredging	• Dredging will be undertaken in such a way as to reduce the impacts of dredging on estuarine biota, including waterbirds, by following the following management measures: o Dredging methods that resuspend the least quantity of fine-grained sediment into the water column will be used. o The dredging footprint will be restricted to the smallest area and depth possible. o Overflow or leakage from the hopper and barge compartments will be prevented. o Hoppers and barges will not be overfilled. o Techniques to reduce the extent of the turbidity plume will be used.	While dredging in both the construction and operational phases.	Dredging results in a minimum turbidity plume extent. No spillage of sediment into the estuary occurs.
14	Changes in estuarine water quality due to stormwater runoff	• Construction plans to ensure erosion control, sediment retention and good housekeeping on the construction site will be developed and implemented. These plans will include and expand on the existing mitigation measures for this impact,	Developed prior to construction	Erosion control, sediment

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
		for example: o Excess sediment will be safely disposed of. o Earth moving will be avoided during the wet season. o Erosion control measures such as silt fences will be implemented in areas at risk of erosion/runoff. o Any sand piles left for long periods of time will be secured with geotextile material to prevent wind mobilisation into the estuary. o Any erosion damage occurring after heavy rainfall events will be repaired.	and implemented daily during the construction phase.	retention and good sediment housekeeping is evident on the construction site. There is little increase in sediment runoff into the estuary.
15	Disturbance of avifauna	• Waterbird survey has been carried out during January 2024 when the birds are likely to be present in the Project area. It is during this period that waterbirds travel south from their northern hemisphere breeding grounds to their southern hemisphere feeding grounds. • Construction activities will be adapted to reduce impacts on avifauna by following the recommended mitigation measures. For example: o The duration of construction activities near the estuary will be limited as far as possible. o Loud construction activities, including large vehicle traffic, will be restricted to times outside of peak waterbird feeding time i.e., commencing at least an hour after dawn and ending at least an hour before dusk. o No construction activities will be permitted between sunset and sunrise. o Construction will be timed so that the loudest period does not coincide with the dry season, which is the main migratory bird season. o “Soft starts” will be employed to reduce the startle response of birds and allow birds to leave the area prior to the commencement of very loud activities.	Water bird survey will be carried out quarterly during construction and during Environmental Audit of operations.	A Waterbird Survey is undertaken and its findings are used in adaptive management so that the impacts of the Project on avifauna are reduced.
16	Light pollution from the Project	• Before construction, a light-at-night survey will be undertaken to determine the baseline illumination levels in estuarine habitats near the development site, such that future monitoring has a reference point. • All recommended mitigation measures will be implemented to reduce the amount of artificial light emitted by Project construction and operations, thereby reducing impacts on estuarine biota. For example: o All excess or unnecessary lights will be removed.	Commencing before construction and continuing throughout construction	A light-at-night survey is undertaken and is used to inform adaptive management

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
		o Only areas in use will be illuminated. o Uplighting and water illuminated will be restricted. o Adaptive light controls will be used to manage light timing, intensity and colour. o Lights will be kept close to the ground, directed, and shielded to avoid light spill. o The lowest intensity lighting appropriate for the task will be used. o Non-reflective surfaces will be used where possible. o Lights with reduced or filtered blue, violet, and ultraviolet wavelengths will be used. Redder or yellower wavelengths will be favoured. o Motion sensors will be used to turn lights on only when needed.	and operations.	to reduce the impacts of light on estuarine biota. All recommended mitigation measures regarding lighting are followed as far as safely possible.

7.3.2 TERRESTRIAL BIODIVERSITY MANAGEMENT PLAN

7.3.2.1 OBJECTIVES

The management of biodiversity at the terrestrial level and exposed shoreline aims to:

- Contribute to the avoidance and minimization of degradation of surrounding natural and semi-natural habitat to the extent possible by the Project.
- Ensure the continued control and reduction of alien invasive species on and surrounding the Project site.
- Avoid mortality of and minimize further disturbance to indigenous fauna.
- Ensure potential impacts by unplanned events can be contained rapidly and kept to the minimal magnitude and extent possible.
- Provide for rehabilitation guidelines after disturbances, especially after construction and after an unplanned event.
- Provide a measurable verification and recording of the efficiency of the mitigation and management measures implemented, and adaptive management options as needed.

7.3.2.2 PROJECT ACTIVITIES RESULTING IN TERRESTRIAL BIODIVERSITY IMPACTS

Pre-Construction Phase

Sources of impacts to terrestrial biodiversity during the pre-construction phase include:

- Clearing and landscaping of the site of approximately 20 ha prior to construction, with complete loss of modified habitat on the Project site.
- Dredging, excavation and clearing of up to 400 m of the shoreline to allow building of the ± 300m quay structure, which may involve some clearing of remnant mangrove vegetation (including alien invasive species) at the interface between terrestrial and estuarine habitats.
- Chemical and hydrocarbon spills may arise from heavy machinery and vehicles operational on site.
- Some degree of dust emissions can be anticipated, as well as vehicle and machinery emissions.
- Littering and pollution may arise from inadequate waste disposal facilities and/or practices, as well as potential lack of adequate washrooms and associated facilities.
- Potential mortality and anticipated displacement of fauna.

Construction Phase

Sources of impacts to terrestrial biodiversity during the construction phase include:

- Construction activities, including introduction of materials.
- Installation of two water supply wells and associated storage tanks.
- Chemical and hydrocarbon spills may arise from heavy machinery and vehicles operational on site.
- Some degree of dust emissions can be anticipated, as well as vehicle and machinery emissions.

- Littering and pollution may arise from inadequate waste disposal facilities and/or practices, as well as potential lack of adequate washrooms and associated facilities.
- Potential mortality and anticipated displacement of fauna.
- Potential increased establishment or spread of alien invasive species.
- Potential indirect impacts on local biodiversity resulting from construction labour sourced from outside Port Onne communities, which are assumed to be largely outside the direct control of the Project.

Operational Phase

Sources of impacts to terrestrial biodiversity during the operational phase include:

- Chemical and hydrocarbon spills may arise from heavy machinery and vehicles operational on site (including workshops and maintenance areas); spills may also result from unforeseen events around the respective chemical and hydrocarbon storage systems.
    - Storage and handling of urea and liquid ammonia (including emergency ammonia vapour flaring in case of any need) may pose the most significant impact on terrestrial biodiversity in case of an unforeseen event.
    - In an unforeseen event of accidents or other along the existing transport routes from the production plant to the loading facility, spillages may also have a detrimental impact on biodiversity. This is briefly discussed, although this may occur outside the selected AoI.
- Power generation engines and associated exhausts, machinery and vehicles creating a continuous source of noise and emissions.
- Potential disturbance of fauna by high light levels
- Potential repeated dredging and related impacts on shorelines.
- Waste disposal, including sewage treatment and subsequent discharge outside of premises.
- Potential increased establishment of alien invasive species.

7.3.2.3 RESPONSIBILITY

MM FZE, as Project owner, shall assume responsibility for ensuring the terrestrial biodiversity management system throughout life of the Project. During construction, field implementation will be managed and executed by the Contractor. Other parties, such as the Engineer, will also assume certain responsibilities in this regard which are detailed below.

7.3.2.4 Performance Criteria

- Contribute to the avoidance and minimization of degradation of surrounding natural and semi-natural habitat to the extent possible by the Project.
- Ensure the continued control and reduction of alien invasive species on and surrounding the Project site and no additional spread or introduction of alien invasive species.
- No mortality of and minimal further disturbance to indigenous fauna.
- Potential impacts by unplanned events are contained rapidly and kept to the minimal magnitude and extent possible.
- Provide for and implementation of rehabilitation guidelines after disturbances, especially after construction and after an unplanned event.
- Provide a measurable verification and recording of the efficiency of the mitigation and management measures implemented, and adaptive management options as needed.

7.3.2.5 Management Measures

The management measures included in Table 7-10 will be implemented to reduce adverse impacts on terrestrial biodiversity from the Project.

TABLE 7-10TERRESTRIAL BIODIVERSITY MANAGEMENT

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
1.	Planning and design: Document control and procedures	• Determine a document control system for all actions related to biodiversity, including maintenance of a biodiversity incident and observations register. • Link incident registers or implementation reports to a GIS database • Ensure biodiversity mitigation measures are incorporated and adequately cross-referenced in all relevant management plans (with emphasis on waste management and emergency response plans), policies as well as carried over to all contractors employed for the Project. • Appoint an Environmental Officer or similar to take on oversight of all matters relating to biodiversity. Ensure that all contractors have the same capacity to ensure full compliance. • Avoid construction-related faunal mortality or injury by: o Drafting a faunal handling procedure that will cater for: ▪ Safe removal of potentially dangerous fauna. ▪ Handling of potential undesirable human-wildlife interactions. ▪ Safe relocation of fauna. ▪ Suitable and prompt handling and treatment of potentially injured fauna, • Avoid additional or continued re-establishment of alien invasive flora by: o Drafting an alien plant control plan, complete with an identification guide of alien invasive plants and relevant control measures. Control measures will likely be most effective by using a combination of manual, mechanical and use of appropriate chemical control measures. Control measures shall be complemented by a suitable monitoring and early detection program. o Avoiding using topsoil of areas already invaded by alien plants in rehabilitation or landscaping purposes – only use such contaminated soils where they will be deeply buried or sealed to ensure regenerative material contained in such soils gets destroyed. o Include an early warning system for any new plants as may be introduced by wind, floods or carried in by transporters (also ships). • Biodiversity Management Plan (BMP), including a Biodiversity Monitoring Program (with indication of frequency of monitoring) and above measures, must be drafted at the latest by the time the pre-construction phase has been completed, and be revised every 5 years. Monitoring measures need to verify measurable efficiency of management measures implemented, and will include as a minimum:	Pre-Construction Maintain and update during construction and operation	Full implementation overview, verification of efficiency of mitigation measures. Efficient and cost-saving coordination of biodiversity management, mitigation implementation and rehabilitation success. Project-specific BMP. faunal handling procedure. Comprehensive alien and invasive species control plan. Comprehensive biodiversity monitoring actions. Verification of and enablement of adaptive management by

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
		o Faunal monitoring, especially where species choose to roost or otherwise 'more permanently use' the Project site to ensure the compatibility of such with Project operations, prioritising the safety of indigenous fauna. o Vigour of mangrove patches in close proximity of the quay, especially following dredging, and any unplanned adverse events. o Aligned to the water-management plan (Section 7.2.4 and Section 7.2.5), ensure regular monitoring of the quality of runoff and other water discharged to the environment. Also monitor the quality of groundwater and surface water in close proximity to the Project site, incorporating aquatic indicators such as macroinvertebrates and/or diatoms. Increase the frequency and extent of this monitoring after occurrence of an adverse unplanned event.		regular review of the BMP overall.
2.	Planning and design: Clearing methods and material handling	• Provide appropriate methods and a detailed description of how mobilization and clearing activities need to be conducted to reduce unnecessary destruction of habitat and loss of fauna. • Pre-determine where and how temporary soil stockpiles will be stored (topsoil and separate subsoil) in a way that does not create further damage to shorelines, rivers, or any natural habitat, does not lead to accelerated erosion and does not allow the establishment of alien invasive species. • Pre-determine how grubbed biomass will be disposed of, ensuring that regenerative material from alien invasive plants is appropriately destroyed. o As far as practically feasible, cleared biomass should be processed at the clearing locality within 72 hours of clearing, and usage of different types of material (logs, branches, brush) predetermined. E.g. logs may be used commercially, branches donated as firewood and brush processed further either as mulch or brush packing. Cleared material will not be allowed to smother any habitat outside the Project footprint. • Aligned to the waste-management and emergency response plan, the following needs to be implemented to protect biodiversity: o Cleared and sealed surfaces need to be fitted with sufficient stormwater drainage systems – aligned with the surface water management plan - to prevent direct discharge into the environment. Areas prone to chemical or hydrocarbon spills need to have stormwater drainage fitted with relevant separating sumps or other to ensure water is adequately treated prior to controlled release into the environment	Pre-Construction Implementation during construction	Loss of indigenous natural resources and associated ecosystem services limited to the minimal extent possible. No degradation of habitats or reduction of ecosystem services outside the Project footprint due to Project activities.

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
3.	Planning and design: Preparation for adequate awareness raising	• Ensure biodiversity concerns are adequately incorporated in all induction training presented to all Project staff, construction staff as well as site visitors. • Induction material shall include sufficient visual material to make biodiversity sensitivities clear. • Induction materials need to make it clear that a strict "no-poaching, no-hunting" policy, including the ban in trade of wild-harvested indigenous fauna and flora resources from/with local communities will be maintained by all personnel and contractors who work at or visit the Project or associated sites. The only exception will be allowing the purchase of fish from communities for own consumption, provided this is purchased from communal markets. • No open fires may be lit for cooking or any other purposes, unless in specifically designated and secured areas to avoid accidental fires	Ongoing: Preconstruction Construction Operation	Full compliance of all staff, contractors, visitors to all biodiversity management measures
4.	Planning and design: Rehabilitation	• Determine actions and requirements for biodiversity rehabilitation and/or final site landscaping, which are to be incorporated into the site rehabilitation and/or biodiversity management plan. This needs to include specification around: o Erosion control measures specified including repair to rills, gullies or other as may arise after high rainfall events and unforeseen extreme weather. o Final landscaping to surroundings and rehabilitation of all disturbed areas as soon as possible post construction. o Revegetation of disturbed areas with a dense low grass layer will be prioritised to suppress alien invasive plant establishment. o For all landscaping/gardening of the Project site, primarily indigenous flora will be used and exotic flora species known to be or with a potential to become invasive are clearly excluded. o To the extent possible or necessary, creation of attenuation ponds for stormwater and treated sewage water will be considered, vegetated with sedges and other indigenous water-loving plant for final filtration/absorption of potential pollutants – especially with higher N-levels – prior to discharge to the environment	Initiated during preconstruction and construction. Completed and maintained post-construction	Rehabilitation costs optimised due to wise handling of resources and implementation at the soonest possibility. No accelerated erosion due to bare unstable soils. No undesirable plant species within final landscaped areas.

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
5.	Planning and design: Design Mitigation	■ Design berms and/or stormwater management structures to prevent runoff from the construction areas during/after a periodic rainfall events to enter directly into rivers o Ensure separating sumps or other filtering mechanisms linked to runoff and sewage treatment are fully functional and cleaned out regularly to ensure water is adequately treated prior to controlled release into the environment. • Water, including runoff, potentially contaminated with hydrocarbons, ammonia, urea, nitrogen or other may not be allowed to enter any storm drains (unless such are connected to a separator sump), rivers or drainages. The same applies to contaminated water that may arise from containing vapours, related fires or other incidents as may be reasonably anticipated to occur during the construction or operational phase. • Limiting lighting levels at night to essential areas only, and ensuring all lights will be strictly down-lights (i.e. cover above) as low as possible to the ground and directed at active operational areas. Lighting should be restricted to minimal motion-activated lighting only or avoided near the shoreline. • Identify any permanent structures that may be attractive to especially avifauna to roost, perch or even breed on, or may be of low visibility to avifauna and ensure: o All electrically live components are duly insulated. o Perch deterrents are added to structures where fauna could become injured, e.g. on or close to the flare stack, wooden beams underneath roofs close to loading and unloading facilities or electrical installations o All above-ground high voltage lines – if there will be any – will be fitted with flight diverters and structures to increase visibility to avifauna. • Current design features that will significantly reduce the risk of operational adverse impacts include: o Urea transport shall be by covered tipper trucks, and unloading will be inside an enclosed area. The latter will protect urea from rain, and will have controlled temperature and humidity to prevent urea caking and deterioration. o Urea dedusting units at the unloading and loading conveyor belt facilities aims to capture and re-use all urea dust generated during handling. o Ammonia shall be transported by dedicated tankers and the design of these tankers will follow international standards[1]. Ammonia storage tank shall	Initiated and implemented during preconstruction and construction phases. Maintained throughout operation.	Loss of indigenous natural resources and associated ecosystem services limited to the minimal extent possible. No degradation of habitats or reduction of ecosystem services outside the Project footprint due to Project activities.

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
		comply to all latest design standards, but will still be fitted with a natural gas supplied flare stack. During normal operations, there should be no need to use the flare stack for flaring excess ammonia vapours, as the latter that may be generated by unloading, storage or loading arms shall be re-liquefied and sent back to the storage tank		
6.	Site Clearance, excavations, and levelling	• The permissible edge of any area to be cleared or worked on must be demarcated, and no movement of vehicles or machinery will be allowed outside this demarcation. Avoid clearing indigenous mangrove species to the maximal extent possible. • Ensure all staff, contractors and visitors undergo adequate induction and awareness training to be sensitive to biodiversity and be able to respond in an appropriate manner in the case of a biodiversity incident (faunal handling, spillage control, etc.) and comply to all biodiversity-related prohibitions. • Clearing and dredging will preferably be done outside the wet season, and must be discontinued between dusk and sunrise. Limit activities between dusk and sunrise to emergency and safety-related activities only. • Soil stockpiles – anticipated to be temporary - will be located away from shorelines and drainages and surrounded by silt traps. • Cleared plant biomass will be disposed of as determined during the planning stage. • Inspect all bare areas and temporary material stockpiles on and adjacent to the Project footprint for signs of accelerated erosion, especially after high rainfall events and implement immediate mitigation to limit damage. • Create berms and/or stormwater management structures to prevent runoff from the construction areas during/after periodic rainfall events to enter directly into rivers. • Implement dust control on all cleared areas and unpaved roads in alignment with the air quality mitigation measures. • Ensure emissions by vehicles, machinery and power-generating systems are kept at the lowest possible levels (see air quality and climate change mitigation measures) • Initiate rehabilitation measures as soon as possible.	Pre-construction Construction. Continued during operation as required (e.g., during dredging).	Loss of indigenous natural resources and associated ecosystem services limited to the minimal extent possible No degradation of habitats or reduction of ecosystem services outside the Project footprint due to Project activities. No accelerated erosion or contaminated runoff discharging into the environment.

[1] ASME/API standards

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
				No excessive dust or air pollutants that could damage flora and injure fauna.
7.	Injury or loss of fauna	• Inspect all areas at least a month prior to clearing for the presence of any active breeding activity, mark such areas as no-go zones until all offspring have left the relevant nest. • All excavations will be protected by fencing or other means to prevent access to such by fauna, inspected for the potential presence of trapped fauna before resumption of activities, and will be closed as soon as possible. • Similarly, all construction and dredging sites will be inspected at the start of the day's activities for the presence of fauna, and such shall be flushed out or relocated as per faunal handling procedure, ensuring no harm to such. • A duly trained rapid response team shall be identified and/or trained to be ready to respond to all wildlife encounters as per faunal handling procedure, especially snakes and threatened species. o This team shall also be equipped with suitable equipment and PPE to be able to handle fauna without the risk of being bitten by poisonous or disease-carrying animals. o This team shall be trained to identify if an animal has rabies or anthrax, to ensure the right channels are followed to capture and euthanise such animals and adequately dispose of their bodies. o Ensure all staff are aware of these procedures and know whom to approach and what to do in case of a faunal incident. • Aligned to the traffic management plan (Section 7.4.2), all staff, contractors and visitors are to adhere to strict speed limits to avoid faunal mortality or injury due to collisions with vehicles. • In alignment with the waste management plan, limit the amount of plastic waste produced and ensure that no plastic waste ends up in the environment. Create and maintain a habit of cutting all plastic waste such as rings, loops, and nets prior to disposal to prevent the possibility of fauna becoming	Preconstruction Construction Maintained through operation as necessary	No mortality or injury of non-pest fauna. Rapid and correct response to any faunal incidents. Duly maintained faunal incident register.

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
		entrapped and/or strangled by such. • Identify any permanent structures that may be attractive to especially avifauna to roost, perch or even breed on, or may be of low visibility to avifauna and ensure: o All electrically live components are duly insulated. o Perch deterrents are added to structures where fauna could become injured, e.g., on or close to the flare stack, wooden beams underneath roofs close to loading and unloading facilities or electrical installations. o All above-ground high voltage lines – if there will be any – will be fitted with flight diverters and structures to increase visibility to avifauna.		
8.	Disturbance to indigenous fauna	• In addition to above-mentioned design and faunal mitigation: o Limit high noise-emitting operations to between sunrise and dusk as far as possible or identify ways in which high noise levels can be reduced overall. o During operation, monitor the Project area for the re-establishment of nesting/breeding sites and reduce access to such is required. Where such breeding sites pose a danger to fauna or the operational safety, remove before fully established or install deterrent structures after breeding has been completed.	Ongoing: Preconstruction Construction Operation	Minimal disturbance to fauna. No increased risk of Project activities to fauna or fauna posing risks to Project safety.
9.	Alien and invasive plant control	• Compile a detailed pest/AIP control protocol in which the sequence of methods and a list of preferred herbicides/pesticides has been established. This needs to contain: o A reporting and document control system. o Be linked to the emergency response plan (in the unplanned event of a spill). o Include an herbicide application guide, e.g., no application in high winds, before rain, or between 9.00 and 1700 hrs, mixing rates with adjuvant, water and colourant, application methods and equipment. o Include all herbicide MSDS sheets. o Identify specific training needs of staff involved in AIP control. o Refine responsibilities, monitoring and reporting needs as deemed	Ongoing: Preconstruction Construction Operation	No alien invasive species present on the Project site Continued and clear reduction of Nypa palm along the shoreline of the Project

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
		necessary. o The most effective control of alien plants consists of a combination of methods in an integrated management approach, including: ▪ Mechanical control of alien invasive plans (AIPs) includes mowing, hoeing, cultivation, and hand pulling. This is more labour intensive and time-consuming but is a preferred method. As far as possible, mechanical control must be applied before the target plants flower and fruit. If reproductive material is present, such needs to be destroyed in the most practical way possible – note that large-scale burning of material may be prohibited or excessively risky, thus solarization may be an option. ▪ Chemical control of AIPs includes the use of herbicides. This should be done with caution and the compounds of the herbicides used must be verified and approved for use (also according to national legislation), especially in natural habitats close to water resources and people. Selection of herbicides or pesticides needs to consider the extent of species/organisms that can be affected, mobility of the active ingredient in soils and water, and residual times (persistence) of active ingredients in the environment. • Strictly implement the AIP species control plan: o Create an early detection and control system for plants that could be introduced to the Project site, by e.g., investigating what could be present along transport routes and having an identification guide for such species on hand. o Monitor all disturbed areas and potential temporary stockpiles of topsoil and/or subsoil at least on a monthly basis for the emergence of undesirable alien invasive plants and eradicate immediately to prevent production of regenerative material. o Records of control measures and efficiency will be kept as part of the document control system to enable continued improvement of control measures and associated reduction of costs as the most efficient and early control measures are implemented. o Update the control plan as needed, but at least every 5 years. • Determine prior to start of works how biomass of alien invasive plants cleared can most efficiently be destroyed in such way that regenerative materials will be obliterated to reduce continued levels of re-establishment of such flora.		No degradation of habitats or reduction of ecosystem services outside the Project footprint due to continued or increased establishment of undesirable species Improved awareness of all staff, contractors and visitors on the identity, threat to biodiversity and control of undesirable species

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
		• Avoiding using topsoil of areas already invaded by alien plants in rehabilitation or landscaping purposes – only use such contaminated soils where they will be deeply buried or sealed to ensure regenerative material contained in such soils gets destroyed. • Encourage the continuous harvesting and collection of seeds of the Nypa palm off the shoreline and mangrove habitats to prevent the continuous proliferation of this species. Such seeds could be used as firewood and are commonly used for smoking fish.		
10.	Spillages and Waste	• Cleared and sealed surfaces need to be fitted with sufficient stormwater drainage systems – aligned with the surface water management plan - to prevent direct discharge into the environment. Areas prone to chemical or hydrocarbon spills need to have stormwater drainage fitted with relevant separating sumps or other to ensure water is adequately treated prior to controlled release into the environment. • Spillages of all hazardous chemicals and large hydrocarbon spills need to be contained with urgency as they may be extremely toxic to biodiversity and treated in accordance with the hazardous waste management plan to prevent such chemicals spreading into surrounding habitats. • The above spillage control also needs to be implemented in the case of an unforeseen accident or breakdown of machinery, vehicles or trucks (also along transport routes outside the AoI), especially where trucks transport hydrocarbons and chemicals. • Areas where spillage of soil contaminants occurs, must be excavated (to the depth of contamination) and suitably rehabilitated. If any other minor spillage occurs the spillage must be cleaned as soon as possible, but within the same shift and the contaminated area must be reinstated. All contaminated material should be suitably treated and cleaned, preferably by bio-piles where such is feasible or handed to a suitably qualified third party for cleaning. • Parking and operational areas must be regularly inspected for oil spills and covered with an impermeable or absorbent layer or grease pans (with the necessary storm water control) if oil and fuel spillages are highly likely to occur. • All Project vehicles must only be washed at designated wash bays on site. These wash bays need to be fitted with oil/grease and sediment traps for grey water. • Adequate waste-disposal or organic waste, plastic waste and wash-room	Ongoing: Preconstruction Construction Operation	No degradation of habitats or reduction of ecosystem services outside the Project footprint due to contamination from spills or other waste. No discharge of contaminated runoff or other water to the environment. No attraction of unwanted insects or pest fauna due to organic waste or contaminated

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
		facilities shall be provided to avoid littering, defecation in the bush, related pollution, and the potential attraction of undesirable faunal pest species. • Where reasonably possible, avoid unloading and loading works between dusk and sunrise as well as during high wind and high rain conditions. For the latter, clearly define what are safe environmental operating conditions, and set thresholds for wind, rain or other unfavourable environmental conditions under which loading and offloading may create a significant risk of spillage and/or other damage to biodiversity. • Aligned to the waste-management- and air quality plans, continually monitor emission levels, dust levels and areas prone to chemical and hydrocarbon spills to enable timeous mitigations. • Continually inspect all stormwater drainage systems – aligned with the surface water management plan (Section 7.2.5) - to ensure there is no direct discharge into the environment.		water. Rapid containment of unplanned spillages and minimal extent of such. No injury to fauna or damage to flora due to air pollutants.
11.	Unplanned events	• Avoidance will be key priority and strived for by diligently implementing design and other mitigation as listed for the operational phase. • Avoid the extent of adverse impacts by: o Anticipating all potential required mitigation necessary in the emergency response plan and being fully prepared for any unplanned event – especially spillages, accidents, and extreme weather. o Being aware of and notifying livestock producers operating near to and downwind of a release or potential release to enable such to take appropriate action. • Avoidance of repeat unplanned events, or reduced impacts associated to unplanned events will be strived for by a full evaluation of impacts on biodiversity after an unplanned event (e.g., investigating the extent of scorching to plants if flaring occurred), and determining if improvements can be made to plant design, operational measures and/or enhanced biodiversity protection actions. • Ensure that the Biodiversity Management Plan has a full set of monitoring requirements and methods specified for at least flooding, all types of spillages, flaring, storms, and 'general' unplanned events. • After every unplanned event, evaluate how effective existing mitigation and	Ongoing: Preconstruction Construction Operation	Rapid containment of unplanned spillages and minimal extent of such. Full evaluation of events and continued improvement of preparedness and avoidance. No grievances from community

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
		emergency response management measures were, what could not be mitigated and extent and damage of residual impacts, and then update the Biodiversity Management Plan and all related actions in other management plans to improve mitigation for the potential next unplanned event. o The above needs to emphasize early warning systems, shut-down actions, and containment. • Ensure mitigation and management for biodiversity in unplanned events is aligned to or can potentially feed into the general management of the Bonny River Channel		members or other stakeholders due to damages incurred from Project 'spill-overs' after an unplanned event.

7.4 SOCIAL MANAGEMENT PLAN

7.4.1 SOCIO-ECONOMIC MANAGEMENT PLAN

7.4.1.1 OBJECTIVES

The objectives of the socio-economic management plan are to:

- Manage the socio-economic aspects of the proposed Project development and operation.
- Appropriately manage risks and impacts with social consequences in line with the scale of the proposed Project and in line with IFC Performance Standards 1, 2, and 4.

7.4.1.2 PROJECT ACTIVITIES RESULTING IN SOCIO-ECONOMIC IMPACTS

- Temporary direct and indirect employment opportunities during construction phase and permanent direct and indirect employment opportunities during operational phase.
- Economic benefits from taxes and fees, procurement, and worker spending.
- Increased public health and safety risks due to increased use of local[1] roads for the transportation of workers and equipment during construction phase, and transportation of ammonia and urea products for export during operational phase.
- Presence of a temporary contractor workforce during construction phase, increasing risk for the spread of communicable diseases and reducing access to healthcare facilities, and increasing pressure on local social resources and public services (e.g., accommodation, schools, competition for livelihood and natural resources).
- Possible infringement on human rights due to use of private and public security forces to secure the Project site during construction and operational phases.
- Potential disruption to local fishing livelihoods in waterways surrounding the Project site during site establishment, construction, and operation.

7.4.1.3 RESPONSIBILITY

MM FZE, as Project owner, shall assume responsibility for ensuring the social management system throughout life of the Project. During construction, the implementation of measures will be managed and executed by the Contractor and MM FZE jointly. Other parties, such as the Engineer and Community Relation Officers, will also assume certain responsibilities in this regard which are detailed below.

7.4.1.4 PERFORMANCE CRITERIA

- Maximising employment of low-wage labour and semi-skilled labourers from local communities. Maximising the procurement of local content, where possible, from local communities.
- Proactively engaging communities potentially affected by negative impacts and seeking their inputs into proposed mitigation and management measures.
- Timeous receipt and resolution of grievances related to worker and contractor conduct, gender-based harm, nuisance environmental impacts, traffic-related impacts, among others.

[1] For the purposes of this ESMMP, local is defined as the towns of Ogu, part of the Ogu-Bolo Local Government Area of Rivers State, and Onne, in Eleme Local Government Area. Other immediately surrounding settlements impacted, such as Owo Ogono, are also included in the definition of local.

- Adherence to the Voluntary Principles on Security and Human Rights when appointing private security service providers and when engaging with public security forces such as the police or military.
- Updating of the operational stakeholder engagement plan to ensure engagement with external stakeholder commiserate with the Project's potential risks and impacts.
- Implementation of corporate social investments (CSI) initiatives proportionate to MM FZE's expanded footprint, as well as targeting the mitigation of potential Project impacts such as influx.
- In terms of labour and working conditions:
  - Design and implementation of labour and workplace policies aligned to IFC and international labour guidelines.
  - Implementation of an employee grievance mechanism, including for contractor employees.
- Monitoring and evaluation of Construction contractor compliance with international labour guidelines.

7.4.1.5 MANAGEMENT MEASURES

The management measures included in Table 7-11 will be implemented to reduce socio-economic impacts from the Project.

TABLE 7-11 SOCIO-ECONOMIC IMPACT MANAGEMENT

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
1	Economy and Employment	• MM FZE and the Primary contractor will, where reasonable and practical, appoint local contractors and implement a 'locals first' policy, especially for semi and low-wage labour job categories and in line with national legislation. • Before the construction phase commences, MM FZE will develop a process for interacting with representatives from the Project-affected communities to communicate manpower requirements for the Project and confirm the recruitment process. • The local authorities and relevant community representatives will be informed of the final decision regarding the Project and the potential job opportunities for locals and the employment procedures that MM FZE intends following for the construction phase of the Project. • MM FZE shall organise skill acquisition programme for indigenes in different vocational trades for capacity building. • The recruitment selection process will seek to promote gender equality and the employment of women wherever possible.	At least six months before construction commences and ongoing throughout operational phase	• Development and implementation of Local Content / Procurement Plans • A minimum of 5% of employment for operational phase must be female • . • Records of the recruitment processes that reflect Project-affected communities and an employment database.
2	Community Health and Safety	• MM FZE will maximise the use of a local workforce, to minimise the health and safety risks related to interactions between local populations and a large contractor workforce. • Where non-local contractors are unavoidable, MM FZE will provide temporary facilities for primary healthcare services to avoid overwhelming of local healthcare facilities which may include the use of existing Indorama healthcare facilities. • The Incident and grievance management process will be updated to appropriately accommodate grievances related to sexual assault or abuse by contractors, or gender-based harm as a result of Project activities. • MM FZE will design and implement workplace policies in line with IFC guidelines[1], and ensure that Construction contractors do likewise, to prevent gender-based violence and sexual abuse of local communities. • A traffic management plan (Section 7.4.2) will be implemented for the construction and operational phases. Construction contractor	At least six months before construction commences. Policies should be revised annually and comprehensively updated every 5 years.	• Community Health and Safety Plan and Emergency Preparedness and Response Plan in place and effective. • Recruitment and appointment process in place to meet resourcing requirements for implementation of Health and Safety Plans. • Appropriate investigation and resolution of potential

[1] Addressing Gender-Based Violence and Harassment: Emerging Good Practice for the Private Sector (ifc.org) and Supporting Companies to Develop and Manage Community-Based Grievance and Feedback Mechanisms Regarding Sexual Exploitation, Abuse and Harassment (ifc.org)

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
		compliance with this plan will be monitored. The plan will ensure that appropriate measures are put in place to reduce the risk of injuries or fatalities of pedestrians, as well as vehicle accidents with other road users. • All reasonable measures will be taken, during construction, to minimise community exposure to noise, dust, and vibrations. This may include the integration of dust and vibration suppression measures into construction design, as well as the limiting of construction activities to daylight hours only to avoid nuisance to surrounding communities to at night. • MM FZE will design and implement security policies in line with the Voluntary Principles on Security and Human Rights (VPSHR). Local contractors used to carry out security-related services will be compliant with the VPSHR and will be screened for compliance prior to their appointment.		grievances related to gender-based harm. • Reduction of potential traffic incidents to 'as low as reasonably possible' levels. • Zero human rights infringements as a result of private security activities. • VPSHR-compliant security policy in place. • Proof of Voluntary Principles on Security and Human Rights (VPSHR)-compliant subcontractors.
3	Community Stability and Livelihoods	• MM FZE will actively engage with the Oil and Gas Free Zone Area (OGFZA_ Joint Community Relations Committee in order to partner on CSR and social development initiatives, where possible. • MM FZE will incorporate into the Stakeholder Engagement Plan proactive engagements with local communities potentially impacted by construction activities within or adjacent to fishing waters. MM FZE will transparently communicate these impacts, and should the impact be found to be significant; MM FZE will support affected stakeholders through the identification of new fishing areas. • Socio-economic benefits derived to communities through CSI programmes will be adjusted to ensure they are commensurate with the expansion of MM FZE's existing operations. These will be based on the agreements between MM FZE and the jetty communities. • MM FZE will ensure transparent and continued communication with all stakeholders to ensure that community expectations are aligned to what the Project can realistically deliver in terms of CSI. This must include the update of the SEP to include activities related to the Project, as well as continuous oversight to ensure the timely and effective implementation of the plan. • MM FZE will ensure that an updated incident and grievance management process is in place and that it covers the new activities	At least six months before construction commences. Policies and management plans should be revised annually and comprehensively updated every 5 years.	• Corporate social investment initiatives in place to address impact of influx. • Revised operational stakeholder engagement plan to include the proposed Project and consistent local authority and leadership engagement. • Revised corporate social investment strategy in line with expanded activities. • Incident and grievance management process in place for the Project. • Project Database in place for the Project.

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
		undertaken in relation to the Project. Additionally, a Project Database will be regularly updated to track all commitments made to stakeholders and progress in delivering on these.		
4	Labour and Working Conditions	• MM FZE's recruitment policies, standards, and procedures will be transparently communicated to local communities to ensure equal and fair access to employment opportunities, especially for vulnerable groups. • MM FZE will design and implement workplace policies in line with IFC guidelines[1], and ensure that Construction contractors are aligned with these policies on an ongoing basis, to promote working conditions which ensure worker safety and a respect for human rights. Where such policies have already been designed, MM FZE will ensure implementation as well as ongoing monitoring and evaluation of such policies. Particular attention will be given to designing social monitoring and evaluation procedures for Construction contractors. • MM FZE will ensure that all permanent and contractor workers, including those employed by Construction contractors, have access to the employee grievance mechanism, ensuring that allegations of poor or unsafe working conditions or human rights violations can be appropriately investigated.	At least six months before construction commences.	• Revised SEP to ensure local communities are aware of opportunities and recruitment policies, standards, and procedures. • Internationally compliant labour and workplace policies in place and implemented. • Monitoring and evaluation framework in place for contractor social performance. • Employee grievance mechanism in place.

[1] Addressing Gender-Based Violence and Harassment: Emerging Good Practice for the Private Sector (ifc.org) and Supporting Companies to Develop and Manage Community-Based Grievance and Feedback Mechanisms Regarding Sexual Exploitation, Abuse and Harassment (ifc.org)

7.4.2 TRAFFIC MANAGEMENT PLAN

7.4.2.1 OBJECTIVES

The purpose of this plan is to manage and reduce Project-related risks and potential impacts on traffic operations, road condition, and transportation safety risks along affected public roads and the Port of Onne. Project construction and operation will generate additional traffic, including heavy truck trips, on existing public roads between the proposed Project, and surrounding areas.

The impact assessment for this plan identified transportation-related impacts in terms of traffic operations (i.e., congestion and delay), degradation of road facilities, and safety risks during both construction phase and the operations phase. Impacts on traffic congestion, road condition, and safety were found to be minor during construction due to the impact on the heavily travelled East West Road and roadways leading to the port and new port terminal. Impacts during operations were found to be moderate due to the increase in heavy truck traffic caused be the shipment in urea and ammonia. This plan presents the recommended strategies and measures to prevent, mitigate, or reduce potential adverse impacts for affected public roads. This plan also describes monitoring and reporting processes, including identification of the performance indicators.

7.4.2.2 PROJECT ACTIVITIES RESULTING IN TRAFFIC IMPACTS

The Project would include the construction and operation of a port terminal at Onne Port with all associated utilities for the export of urea and ammonia manufactured at the Indorama Complex in Eleme, Port Harcourt. The granulated urea would be transported along the East West Link Road in covered tipper trucks with a 40 MT payload capacity, while liquid ammonia would be transported in dedicated tankers with a 20 MT payload capacity.

The Project will include one vessel berth with a capacity to handle and export 1.4 MMTPA of granulated urea and about 150 KTA (approximately 420 MMTD) of ammonia.

Project activities generating traffic during construction would include the following:

- Employee transportation at the start and end of work shifts, provided primarily by bus and mini-bus. MM FZE estimates approximately 10 mini-buses and 2 buses would be needed per day, with a slight increase in buses during the peak in the earlier months and a lesser number as the construction phase winds down. Additionally, a total of 25 cars and pickup trucks would contribute to traffic during construction.
- Delivery of equipment, supplies, and components during construction would require an estimated 60 trucks daily during construction.
- Delivery of fuel and water would require an estimated 2 trucks daily during construction.

During Operations, traffic would include employees commuting by bus, mini-bus, and small vehicles on the roads along the route from the Indorama Complex to the Project site at the Port of Onne. Delivery trucks and tankers carying urea and ammonia from the Indorama Complex to the Project site would contribute 442 trips per day, an 85% increase over the average daily daytime truck trips at the West Africa Container Terminal

(WACT)/Onne Multipurpose Terminal (OMT), a 32% increase in truck trips at the Federal Ocean Terminal (FOT) Road Nigerian Ports Authority (NPA) Main Entrance Gate, and a 27% increase in truck trips at the Onne Road second roundabout.

Vessel traffic during operation would include the export of urea three times per month and ammonia once every two month. The combined export trips would be a 7% increase of in average monthly vessel traffic from 2022 and 2023.

7.4.2.3 RESPONSIBILITY

MM FZE will have responsibility for implementing the management measures by establishing and continually implementing standards and procedures for its own vehicles and employees and for its Contractors.

The new port terminal will include a new roadway that will connect the WACT/OMT road to the new port terminal entrance and increased turning movements at the intersections of the East West Road at the new access road and Onne Road. MM FZE is responsible for coordinating with the Rivers State Road Authority, the Federal Roads Maintenance Agency, and the Nigerian Port Authority to minimize congestion and maximize safety.

Road maintenance and improvement are governed and implemented by the Federal Roads Maintenance Agency (for the East West Road), the Rivers State Road Maintenance and Rehabilitation Agency (for the Onne Road, the new access road, and other state roads) and the Nigerian Port Authority (for the Federal Ocean Terminal Roadway). This plan recognises that MM FZE has no direct authority or ability to direct or provide road maintenance and improvements but can advocate and provide guidance for such improvements.

7.4.2.4 PERFORMANCE CRITERIA

Performance criteria are included in
Table 7-12 Road and Vessel Traffic Management and include the stakeholder engagement, number of accidents, or grievances and volume of spills.

7.4.2.5 MANAGEMENT MEASURES

The management measures included in
Table 7-12 Road and Vessel Traffic Management will be implemented to reduce traffic impacts from the Project.

TABLE 7-12 ROAD AND VESSEL TRAFFIC MANAGEMENT

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
1	Road Infrastructure Maintenance	• Work with appropriate national and state road authorities to advocate for maintenance of public roads to address pavement deterioration related to Project activity.	Formal engagement with authorities at least annually	• Public road degradation attributable to Project activities are addressed.
2	Road Infrastructure Maintenance	• Maintain the existing Project access road and the proposed new access road in good condition	As needed	• Project access roads are always in good condition.
3	Traffic Management for Improved Safety and Reduced Road Congestion	• Schedule employee shifts and truck deliveries to minimise congestion and conflicts with local traffic at the intersections of the new access road and Onne Road with the East West Highway.	Prepare weekly/monthly schedules for construction and operations; update in response to grievances or other needs	• Traffic management plan and schedule maintained by MM FZE and available for review. • Number of crashes or other traffic incidents at the intersections of the new access road and Onne Road with East West Highway involving Project vehicles.
4	Traffic Management for Improved Safety and Reduced Road Congestion	• Communicate with authorities including the NPA and affected communities (including port users, emergency services, and public transport providers) about lane closures and diversions. • Establish and enforce speed limits within construction areas and along delivery routes during operations. • Use signs (reflective signs and/or flashing lights for night), traffic cones, and positioning of flag persons to direct traffic as necessary.	Prior to and throughout construction and operations	• Use of speed governors, GPS, or other monitoring efforts. • Number of crashes or other traffic incidents at the intersections of the new access road and Onne Road with East West Highway involving Project vehicles.
5	Enhanced Safety through Stakeholder Engagement and Education	• Maintain (or initiate, where needed) relationships with local stakeholders and port users to understand risks particular to the daily traffic patterns and schedules, or when port activities would result in high road use.	Port user meeting at least 6 months prior to construction;	• MM FZE captures meeting notes and makes them available to port users and the public.

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
		• Provide the NPA with construction schedule road usage during operations.	periodic meetings until planning for safety measures and pre-construction road improvements are complete	
6	Enhanced Safety through Stakeholder Engagement and Education	• Provide a grievance mechanism that is easy to access, transparent, and responsive. Accept grievances related to MM FZE road traffic in writing, electronically, by telephone, or verbally at community stakeholder meetings. Create written record of all grievances submitted verbally.	Ongoing availability during construction and operations; initial response within one week; timely resolution or final response	• Number of grievances received. • MM FZE maintains records of grievances, initial response, and final resolution or disposition.
7	Enhanced Safety through Driver Qualification Standards and Training, both General and Project-specific	• Use only drivers with the required driving license. Enforce driver qualifications and training for all drivers, whether employees or sub-contractors. Include requirements in applicable contracts. • Establish driver training program specific to the vehicles, roads and risks encountered for the particular tasks. • Require regular truck driver safety training, defensive driving training, and testing.	Continual during construction and operations. Annual (or more frequent) driver refresher training.	• MM FZE and contractors retain relevant records of licenses and driver training program materials and record of completion for all drivers. • Annual verification of all driving licenses for Project drivers. • Provision of driver training to all Project drivers, including at least annual refresher training. • Number of Project-related Road crashes or other incidents.
8	Enhanced Safety through Consistent safe Driving Practices	• Establish and enforce rest and break standards that comply with national laws, industry standards, and global best practice. • Structure contracts with truck contractors to avoid incentives for speeding or insufficient fatigue breaks. • To the degree permissible by law, require daily	Continual during construction and operations	• MM FZE and contractors provide all drivers with written policies, and require drivers to sign agreement, indicating rest and break standards, drug and alcohol standards, and speeding; managers implement ongoing enforcement of policies.

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
		or periodic drug and alcohol testing for all drivers. • Equip trucks with speed governors or on-board GPS, and/or monitor vehicle speed and location. • To the agree allowed by law, enforce driver quality through loss of jobs or contracts for individual drivers for drug or alcohol offenses, chronic or egregious speeding, or other notable or repeated unsafe behaviours.		• MM FZE contracts prioritise safe driver practices. • Daily or periodic drug and alcohol testing (to the degree allowed by law). • Use of speed governors, GPS, or other monitoring efforts. • Number of MM FZE-related road crashes or other incidents.
9	Vehicles in Good Condition and Safe to Operate on Public Roads	• Require scheduled, preventative vehicle maintenance according to manufacturers' recommendations for all Project vehicles, whether owned by Project or a contractor. • Require completion of a vehicle safety checklist prior to vehicle operation on public roads.	Continual during construction and operations	• Establishment of regular schedule for vehicle preventive maintenance. • Documented completion of scheduled maintenance. • MM FZE and contractor managers require completion of vehicle safety checklist prior to vehicle operation. • MM FZE retains completed checklists for one year.
10	Driver Communication in Case of Emergencies	• Provide uniform in-vehicle communications systems that enable contact with truck traffic controllers and other drivers	Continual during construction and operations	• MM FZE and contractors provide (or require, for independent truck operators) and ensure proper operation of in-vehicle communication systems.
11	Prevention of Nuisance and Visibility Hazard from Airborne Dust or Dirt on Roads	• Wash all trucks leaving the Project site using a dedicated wash station where water can be continually recycled.	Throughout construction	• MM FZE or contractors provide wash station at construction site; require truck washing prior to leaving Project site.
12	Prevention of Hazard and Nuisance from Truck Spills	• Securely cover loads on trucks to minimise spillage and dust.	Throughout construction and operations	• MM FZE and contractors develop and enforce policies requiring truck load covers. • Record of all spill incidents from MM FZE and contractor vehicles.

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
13	Prevention of Hazard and Nuisance from Truck Spills	• Do not overload trucks	Throughout construction and operations	• MM FZE and contractors develop and enforce policies prohibiting truck overloading. • Record of all spill incidents from MM FZE and contractor vehicles.
14	Vessel Traffic Safety	• Observe standard international and local navigation procedures in and around Onne Port, as well as best ship-keeping and navigation practices while at sea. • Require vessels associated with the Project to be equipped with (and to operate) navigation aids, lighting, communications equipment, and radar equipment, consistent with international maritime standards.	Throughout construction and operations	• MM FZE and contractors meet with NPA and understand procedures for Onne Port. • MM FZE ensures all vessels used are equipped with working radar systems.

7.4.3 CULTURAL HERITAGE MANAGEMENT PLAN

7.4.3.1 OBJECTIVES

The purpose of the Cultural Heritage Management Plan is to manage the risks associated with identifying previously unknown cultural heritage resources within the Project AoI that may be exposed during constructed related earth work activities. This may include buried archaeological remains situated beneath the recent infill activity.

7.4.3.2 PROJECT ACTIVITIES RESULTING IN CULTURAL HERITAGE IMPACTS

- The ESIA assessed that there may be no impact from Project related activities relating to identified tangible and intangible cultural heritage resources within the Project AoI.
- There however remains the potential for previously unknown cultural heritage resources to be present beneath the surface and these may be exposed during construction related groundbreaking, earth work activities.
- Unless mitigation is applied, construction related activities may have an impact on previously unknown buried cultural heritage.

7.4.3.3 RESPONSIBILITY

The Project may involve some activities that have the potential to uncover previously unknown cultural heritage. To address any future potential cultural heritage issues, a Chance Finds Procedure (CFP) needs to be developed to remain consistent and complete as a procedure and compliant to international lender standards and international best practice.

7.4.3.4 PERFORMANCE CRITERIA

The CFP is required as exploration, construction and operational activities will likely be undertaken in areas where unknown heritage resources, known as Chance Finds (CF) could be present. The CFP prescribes the measures to be followed to ensure that CFs are managed in manner consistent with the IFC PSs. CFs include movable and immovable objects, sites, structures, or groups of structures having archaeological, paleontological, historical, architectural, religious, aesthetic or other cultural significance.

The purpose of this Plan is to provide guidance to MM FZE on the implementation of CFP, to avoid and minimise any adverse impacts on Cultural Heritage during the construction and operation phases of the Project. The CFP is applicable to all activities conducted by personnel, visitors and contractors that could potentially uncover CFs. It details the actions to be taken when CFs are found during exploration, construction and operational activities. The CFP describes training requirements, immediate actions to be taken when CFs are uncovered, communication and processing protocols, and reporting requirements.

The main objectives of this CFP are to:

- Identify the framework for compliance with Nigerian national law and national institutions charged with protecting Cultural Heritage resources.
- Define and describe the steps which must be followed to manage the discovery of previously unknown objects or sites (CFs), including the preservation and appropriate treatment of these finds, while minimizing any disruption to the Project schedule.

- Provide a consistent approach to chance find management to streamline worker acceptance and compliance; and to minimise impacts to Cultural Heritage resources that may be encountered during the development of the Project.

7.4.3.5 MANAGEMENT MEASURES

The management measures included in *Table 7-13* will be implemented to reduce cultural Heritage impacts from the Project.

TABLE 7-13 CUITURAL HERITAGE MANAGEMENT

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
001	Construction and Operation	Develop a CFP	Prior to construction and throughout the life cycle of the Project	• CFP in place, operational and being implemented. • Complete documentation of CFP implementation through daily and monthly reports. • Verifiable tracking of all Cultural Heritage finds from discovery through development and implementation of treatment plans. • Complete record and documentation of all Cultural Heritage finds
002	Construction and Operation	Training and Awareness for cultural heritage and implementation of CFP The project workforce will be trained on the recognition of sites with historical or cultural value and the actions to be taken in the event of any sites or finds being encountered.	Prior to construction, annually and/or when a new staff member joins as part of induction	• Cultural awareness training included in the Company and Contractors personnel induction process. • Audit of training records

7.5 GENERAL MANAGEMENT

7.5.1 CONSTRUCTION PHASE WASTE MANAGEMENT PLAN

7.5.1.1 OBJECTIVES

The objectives for waste management are to:

- Ensure that the waste strategy for the proposed MM FZE Port Project complies with the Nigerian legislative requirements.
- Ensure alignment with the good practice requirements set out in the IFC Performance Standards and WBG EHS Guidelines.
- Identify high level waste streams associated with the construction phase of the proposed MM FZE Port Project.
- Categorise anticipated waste streams and ensure that the waste management hierarchy model is adopted for waste management, i.e., to **REDUCE** the amount of waste produced on site by procuring bulk goods rather than packaged goods and training workers on waste reductions, and to actively promote the **REUSE**, **RECYCLE** and **RECLAIM** waste management concept and subsequently minimising the amount of waste that needs to be disposed of.
- Ensure the end use of waste is as per its waste category assigned.
- Prevent and protect soil; surface water and groundwater from contamination through hazardous substance (including sewage) spills.
- Prevent and protect flora, fauna and people from indirect impacts associated with contaminated soil and water (both surface- and groundwater).
- Prevent health impacts arising via contact with general and/ or hazardous waste.
- Manage waste storage facilities in such a manner to minimise social as well as visual impacts.

7.5.1.2 PROJECT ACTIVITIES RESULTING IN WASTE

Wastes generated from Project activities can be categorised as non-hazardous or hazardous according to their types and associated risks. The definitions of waste categories are as follows:

- **Non-hazardous Wastes** – wastes that do not exhibit any hazardous properties and are relatively low risk to human health and the environment. This category would include a range of materials that may be recycled or can safely be disposed of in a landfill.
- **Hazardous Wastes** – wastes that exhibit one or more characteristics which mean that the wastes are potentially harmful to human health and/or can cause damage to the environment (air, land, and/or water) or natural ecosystems. For example, the waste may be corrosive, reactive, toxic, mutagenic, teratogenic, infectious, carcinogenic, ecotoxic, flammable, or explosive.

Note - during the operational phase, wastes contributed by the proposed MM FZE Project will form part of the existing waste management system associated with the existing OIS Indorama Port operations. To this end, MM FZE will update their Waste Management Plan to accommodate operational aspects of the Project.

7.5.1.3 RESPONSIBILITY

MM FZE, as Project owner, shall assume responsibility for ensuring the waste management systems are implemented and aligned with the requirements under Nigerian Law. During construction, field implementation and management/storage/disposal of construction wastes are the responsibility of the Contractor. Other parties, such as the Engineer, will also assume certain responsibilities in this regard which are detailed below.

7.5.1.4 PERFORMANCE CRITERIA

- Zero incidents of illegal dumping of wastes, both general and hazardous.
- Zero discharge of raw sewage directly into the environment
- No unauthorised access to the waste storage facilities.
- No loss of health to personnel or third parties as a result of inappropriate waste management practices.
- All waste disposal to be carried out by a licensed waste contractor per the Nigerian legislated requirements.

7.5.1.5 MANAGEMENT MEASURES

The management measures included in *SectionError: Reference source not found* will be implemented to reduce waste related dredging and spoil impacts from the Project. The Table 7-14 below presents management measures proposed for managing general waste.

TABLE 7-14 WASTE MANAGEMENT (DURING THE CONSTRUCTION PHASE)

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
		Waste Management Method Statements		
1.	Waste Management Procedure	• Waste Management Procedure shall be prepared covering all waste expected to be generate during construction. The Waste Management Procedure will need to include methods associated with waste handling; waste transport; waste storage and segregation; and waste disposal / treatment / recycling / reclamation options identified for the proposed MM FZE Port Project.	Prior to construction	• Waste Management Procedure
		Waste Handling		
2.	Waste Segregation	• Waste will be segregated according to its composition, source, and type at source and contained in appropriately labelled and/or colour coded waste containers or waste skips.	Throughout construction	• Proper segregation of waste in appropriately labelled waste containers
3.	Waste Containers	• Appropriately labelled bins will be located in all locations onsite where waste is generated and will make provision for the sorting of solid waste.	Throughout construction	• Adequate number of bins
4.		• All bulk waste containers on site (skips, bins, drums etc.) shall be appropriately labelled to show what class and type of waste can be disposed of in them.	Throughout construction	• Appropriately labelled waste containers
5.		• Waste containers will be appropriately designed in terms of volume, composition, and shape. Containers that may react with the waste to produce a harmful substance will not be used. All waste containers will be secured to prevent spillage and interference from birds and animals.	Throughout construction	• Provision of adequate waste containers
6.		• Only one class or type of waste will be stored in	Throughout construction	• Waste separation

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
		each container.		
7.		• All waste containers will be closed with a lid and kept at designated area.	Throughout construction	• Enclosed waste containers in accessed controlled area
8.	Mixing of Wastes	• Solid and liquid wastes will not be mixed.	Throughout construction	• Segregation of solid and liquid wastes
9.	Waste Handling and Training	• All waste will be handled in accordance with its class (hazardous or non-hazardous) and personnel collecting, handling, transporting, or disposing of waste will be trained in the proper procedures for dealing with the said waste class.	Throughout construction	• Training records
10.	Waste Management	• To promote "4Rs" (Reduce, Reuse, Recycle and Reclaim) waste management concept, all waste will be sorted and managed as appropriate, either for reuse, recycling, or disposal.	Throughout construction	• Waste logs
11.	Wastewater (including sewage)	• All wastewater (including sewage) will be treated onsite and treated wastewater discharge will be in compliance with the ambient water quality criteria for the area where discharge will take place.	Throughout construction	• As per 7.2.5 on Surface Water management
12.	Concrete Waste Management	• A concrete washing area will be set aside for concrete trucks, to avoid build-up of waste concrete in site areas.	Throughout construction	• Concrete washing area. No build-up of waste concrete on site
13.	Vehicular Repair and Maintenance	• Vehicle repair and maintenance pits will be regularly cleaned, and any liquid build-up will be removed and treated as necessary.	Throughout construction	• No build-up of liquids
Waste Transport				

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
14.	Transport Containers	• The nature, composition and integrity of transport packaging and containers will be appropriate to the type and class of waste being transported.	Throughout construction	• Designated waste transport vehicles
15.	Transport Vehicles	• Transport vehicles will cater for the type, class and quantity of waste being transported in terms of its composition, load capacity, covering etc.	Throughout construction	
16.		• All transport vehicles will be equipped with suitable materials or equipment to contain, manage, and remove accidental spillages.	Throughout construction	
17.		• Vehicles carrying hazardous wastes shall be labelled appropriately.	Throughout construction	• Labelling of waste trucks
18.	Waste Loading and Unloading	• Loading and unloading as per waste management procedure procedures to avoid waste loss will be followed.	Throughout construction	• Training records, site inspection
19.	Training	• Employees associated with transport of waste will be trained in the correct procedure to address accidents and emergencies.	Throughout construction	• Training records
Waste Storage and Segregation for Non-hazardous Waste				
20.	Waste Segregation	• Non-hazardous waste will be segregated into specific waste types, for those waste types that can either be recycled, reused, or reclaimed.	Throughout construction	• Waste segregation
21.	Waste Storage Areas	• Separate storage areas will be constructed and utilised where appropriate. Separate storage areas will be appropriately designated and labelled.	Prior to construction	• Waste segregation
22.	Mixing of Wastes	• If by error a hazardous waste is mixed with non-hazardous waste, the entire consignment will be regarded as hazardous.	Throughout construction	• Operating procedure and waste management records

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
Waste Storage and Segregation for Hazardous Waste				
23.	Waste Storage Areas	• Temporary hazardous waste storage facilities at the main waste handling facility will be appropriately designed to prevent any contamination of the physical, biological, and social environments.	Prior to construction	• Provision of adequate hazardous waste storage facilities
24.		• Where appropriate, hazardous waste will be stored in sealed containers and placed in a fenced and gated storage facility within the main waste handling facility. The facility will have an impermeable floor, bunded and be covered to prevent rain from entering.	Throughout construction	
25.	Hazardous Waste Storage Duration	Hazardous waste will be temporarily stored before being collected by an authorised contractor for removal and offsite disposal, in an accredited facility. Removal of hazardous waste from site will follow a regular schedule (frequency to be determined). In this respect, the Contractor will adopt the 'cradle to grave' principle. Tracking documents, proving that the disposal of hazardous wastes has been delivered to an accredited facility, and disposed of in such a facility, correctly, will be retained by the Project for audit and verification purposes.	Throughout construction	• Record of up-to-date tracking documents
26.	Sewage	Treated sewage will conform to recognised sewage effluent standards before discharge into the environment.	Throughout construction	
Disposal / Treatment / Recycling / Reclamation				

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
27.	Auditing Waste Contractors	The Project will audit waste contractors prior to agreeing any formal contracts and will ensure that all facilities that receive wastes from the proposed MM FZE Port Project are suitable and in line with the Nigeria National policy on Solid Waste Management 2020 and IFC EHS General Guideline for Waste management (1.6). Waste contractors will need to keep detailed records on how waste from the Project has been disposed, or a facility as approved by respective authority.	Prior to construction	Audit records
28.	Removal of Waste	All remaining waste including (but not limited to) used materials, broken concrete, redundant fencing, fence posts, and litter will be removed when construction sites are closed. Waste will not be buried within the protected areas.	At the end of the construction phase for a specific section of the proposed MM FZE Project	Audit records

7.5.2 SPILL PREVENTION, CONTROL AND CONTAINMENT MANAGEMENT PLAN

7.5.2.1 OBJECTIVES

The objectives for spill prevention, control and containment management are to:

- Protect the environment and community members who are dependent on its natural resources through the development of spill response and containment strategies and capabilities.
- Identify the sources of potential land contamination associated with construction activities.
- Categorise potential spill hazards.
- Plan for rapid and efficient response to manage hazardous material spills during construction.
- Identify and document management measures to prevent, control and mitigate spill events during construction.

7.5.2.2 PROJECT ACTIVITIES RESULTING IN SPILLAGE IMPACTS

During the construction phase of the proposed MM FZE Project, dangerous or hazardous chemicals may accidentally be released into the environment in the form of small spills or a major unplanned event (e.g., oil tanker or cement truck accident). Spillages may occur as a result of leakage of containers used to store or transport the following pollutants:

- Hydrocarbons (including diesel, greases, oils and other lubricants);
- Hazardous chemicals / materials (e.g., paints, batteries, etc.);
- Cement; and
- Effluent.

7.5.2.3 RESPONSIBILITY

MM FZE, as Project owner, shall assume responsibility for ensuring spill management and prevention requirements are established and implemented on the Project. During construction, field implementation of the spill prevention and management controls will be executed by the Contractor.

7.5.2.4 PERFORMANCE CRITERIA

- No unplanned release of dangerous goods or hazardous substances.
- All transport, storage and handling of dangerous goods or hazardous and dangerous substances is performed in accordance with the materials safety data sheets for the chemicals and the management measures included in this ESMMP.

7.5.2.5 MANAGEMENT MEASURES

The management measures included in *Table 7-15* will be for spill prevention, control, and containment management.

TABLE 7-15 SPILL PREVENTION, CONTROL AND CONTAINMENT MANAGEMENT (DURING THE CONSTRUCTION PHASE)

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
		Spill Prevention		
1.	Training	• Training regarding proper methods for transporting, transferring, and handling hazardous substances that have the potential to impact surface- and groundwater resources.	Throughout construction	• Training records
2.		• Train personnel with responsibility for hazardous substances. No untrained staff shall be allowed to handle hazardous substances.	Throughout construction	• Training records
3.	General Management	• Concrete batching/mixing shall only take place at agreed specific areas on site and runoff from the batching area will not be allowed to flow into natural streams and watercourses.	Throughout construction	• No concrete batching in non-designated areas
4.		• Provide collection systems (i.e., drip trays or impervious linings) under machinery or stationary equipment that may dispense or leak hydrocarbons / hazardous substances (i.e., generators and pumps).	Throughout construction	• Collection systems in place
5.		• The bulk loading and unloading of hazardous materials and fuels will be confined to areas that are provided with secondary containment and in line with hazardous material handling procedures.	Throughout construction	• Suitably designed areas for loading and offloading
6.		• Maintain an inventory of all dangerous and hazardous goods onsite, together with all relevant Safety Data Sheets (SDS) for all contaminants on-site. These will include human health effects of chemicals handled and will be included in the required chemical environmental and safety training for all employees handling or otherwise exposed to the contaminants. All appropriate personal	Throughout construction	• Inventory, SDS, training records and suitable PPE

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
		protective equipment, handling and response procedures will also be identified in the SDS or otherwise recommended by the suppliers / manufacturers and followed by all Project staff.		
7.		• Prior to introduction to site, a hazardous material / substance will be reviewed, and proper storage, handling and transportation procedures and spill risk analysis will be established.	Throughout construction	• All procedures in place prior to introduction to site
8.	Transport of Hazardous Materials	• Transportation vehicles and tanks suitable for the hazardous materials being transported will be used. These vehicles and tanks will be maintained in adequate condition to ensure proper handling and safety of chemicals.	Throughout construction	• Records of all deliveries
9.		• Drivers will be trained in spill and emergency response and will have a means of communicating with the site, their administrative offices and emergency personnel for the entire transportation route.	Throughout construction	• Provision of training records for drivers
10.	Storage of Hazardous Materials	• Segregation of corrosive substances that are kept in bulk from incompatible goods and goods with which they may react dangerously.	Throughout construction	• Suitable segregation of goods
11.		• Fuel, lubricants / oils, chemicals, hazardous waste and hazardous material stores and handling areas will be provided with secondary containment capable of holding110% of the largest stored container or 25% of the total volume for all liquids stored in the bunded area. The containment will be checked daily, and debris removed. The storage of such substances shall be maintained away from moving water source or water abstraction source. Further, fuels will be kept away from	Throughout construction	• Bunding of hazardous stores

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
		areas that are at more risk from wildfires (e.g. near dry grasslands).		
12.		• Prevent the integrity and capacity of the bunded areas being compromised by rainwater and stormwater ingress.	Throughout construction	• Records and visual observations
13.		• A preventative maintenance program will be instituted that includes inspection schedules to confirm and maintain the mechanical integrity and operability of storage vessels and associated containment areas and process equipment for fuel, lubricants / oils, chemicals, hazardous waste, and hazardous materials.	Throughout construction	• Evidence of maintenance records/inspection reports
14.		• Hazardous and dangerous material storage areas will be equipped with emergency spill response and fire prevention equipment.	Throughout construction	• Well maintained spill response kits in place at all hazardous and dangerous material storage areas
15.		• Hazchem signage used where hazardous goods are being stored, hazardous materials to be clearly labelled and fencing and controlled access to limit unauthorised access.	Throughout construction	• Signage and access controls in place
		Spill Control and Containment		
16.	Method Statement / Procedure	• Method Statements/Procedure detailing spill emergency response and clean-up procedures for spills will be developed. Emergency response measures will also include methods for response and clean-up for release into any natural stream, river, or wetland. • Emergency response procedures will be tested regularly to ensure rapid response to, containment of, and neutralisation of any spillages.	Start of construction	• Method Statements/Procedure
17.	Spills and Clean-	• Areas where spillage of soil contaminants	Throughout	• Detailed clean-up

Ref No.	Aspect Activity	Management Measure	Timing and Frequency	Target / Performance Indicator
	up	occurs will be excavated (to the depth of contamination) and suitably rehabilitated. If any other minor spillage occurs, the spillage will be cleaned immediately, and the contaminated area will be rehabilitated. All contaminated material will be suitably disposed of. Clean-up procedures will need to be fully recorded.	construction	(incident) records
18.		• Spill kits will be provided at any fuel or chemical storage location. Spill kits must be maintained.	Throughout construction	• Inspection reports showing well maintained spill response kits in place
19.		• Designated and qualified staff designated for responsibility to respond to emergencies.	Throughout construction	• Training records
20.		• A maintained emergency contact list will be placed at all spill response kit locations.	Throughout construction	• Emergency contact list at spill response kit locations
21.		• Development, implementation and regular training and testing of a Project wide Spill Response Plan will be implemented.	Throughout construction	• Training records

8. ENVIRONMENTAL AND SOCIAL MONITORING

8.1 INTRODUCTION

The purpose of the environmental and social monitoring programme is to ensure that management measures, identified and described in Section Error: Reference source not found are implemented and are effective at achieving an acceptable level of compliance with the ESMMP.

8.2 CONSTRUCTION MONITORING

Table 8-16 presents the monitoring specifics / requirements that will be monitored during the pre-construction & construction phase (including post-construction).

Construction activities will be monitored by the MM FZE on site, with regular audits against the requirements of this ESMMP. The ultimate target is to achieve 100% compliance with the ESMMP.

Key aspects to monitor during the pre-construction & construction phase and operational phase include:

- Air Quality;
- Soils and Land Use
- Water Monitoring;
- Biodiversity (Terrestrial and Aquatic) Monitoring;
- Social Monitoring;
- Waste Monitoring; and
- Spill Monitoring.
- Cultural Heritage

Contractor work sites must be monitored during construction, under the guidance of key MM FZE E&S resource persons who will be responsible for reporting the monitoring of the E&S issues. MM FZE may undertake independent monitoring of selected parameters to verify the results of the Contractor and to audit the implementation of environmental mitigation measures contained in this ESMMP and construction contract for the Project.

FMEnv holds the general responsibility for approval of the Project and verifying that applicable environmental guidelines are adhered to during Project implementation. FMEnv's role therefore is to evaluate environmental monitoring and environmental compliance documentation submitted to them, and they would not usually be expected to be directly involved in monitoring the Project unless a specific, major environmental issue arose.

8.3 OPERATIONAL MONITORING

Note – monitoring during the operational phase will be continued as per ESMPP obligations. To this end, MM FZE will update their monitoring campaign to accommodate any additional operational aspects of the Project. Key aspects of monitoring during the operations phase will include:

- Ongoing monitoring of the Project grievance procedure and that any complaints received are being duly handled and closed out.
- Ongoing surface water quality monitoring in the surface water sampling sites included in the MM FZE monitoring network and an additional site on the Bonny Channel.
- Continued monitoring and auditing of the effectiveness of the biodiversity management actions and reviews of at least every 5 years, with adaptive updates to management actions where required.
- Ongoing social monitoring, including (but not limited to) –
  - Number of Project workers screening (health) prior to employment.
  - Ongoing health, education, and training.
  - Ongoing driver training.
  - Ongoing stakeholder engagement.
  - Grievances redress management.
  - Recruitment (in terms of achieving a certain employment percentage from the relevant affected Location and Rivers State.
  - Ongoing OHS induction and training (through toolbox talks).
  - Worker rights being respected and in line with the requirements of Nigerian Law and IFC PS2
- Ongoing waste handling/storage/transport/ disposal monitoring.
- Ongoing spill monitoring.

Table 8-16 Construction and Operation Phase Monitoring

Ref No.	Monitoring Measure	Timing and Frequency	Target / Performance Indicator
Air Quality Monitoring			
1.	• Undertake visual inspections noting events and activities producing visible dust emissions, and action to reduce these emissions as far as practicable. • Record all dust and air quality complaints, identify cause, take appropriate measures to reduce emissions in a timely manner and record the measures taken. • Record any exceptional incidents that cause dust and/or air emissions, either on- or off- site and the action taken to resolve the situation in the logbook. • Record all inspections of haul routes and any subsequent action in a site logbook. • Monthly air quality monitoring for priority pollutants at pre-determined sampling sites	Throughout construction Throughout operations	• Recommendations and corrective actions taken when dust generation or combustion sources are noted. • Complaints arising from air quality emissions managed through the grievance procedure. Benchmarking of results and submission to FMEnv & other relevant stakeholders
Soils and Land Use			
2.	• Monitor the number of vehicles and vehicular movement on site to limit disturbance during installation of the bored piles, construction of the surface infrastructure, and installation of the water supply wells. • Storage of chemicals and hazardous materials in appropriately designed and managed containment areas or containers will be recorded. • Monitor the depth of excavation and restrict it to the soil zone where possible. • Record as-built paved areas (area and size).	Pre-Construction and Construction phase	• Size/area of paved areas • Number of appropriately designed containers • Number of contaminated site/soil clean-ups

Ref No.	Monitoring Measure	Timing and Frequency	Target / Performance Indicator
	• Monitor surface soil erosion during and after rainfall events. • Record and control handling, storage and proper disposal of oil, cleaning fluids, used parts / spares, other contaminated materials such as rags, and chemicals. • Ad hoc servicing of vehicles that could lead to spills onto unpaved areas and contamination of the soil will be prohibited. • Control adherence to proper cleanup procedures after accidental spills or contamination of the soil.		
3.	• Monitor the number of vehicles and vehicular movement on site to limit disturbance during execution of tasks. • Store chemicals and hazardous materials in appropriately designed and managed containment areas or containers. • Monitor surface soil erosion during and after rainfall events. • Record and control handling, storage and proper disposal of oil, cleaning fluids, used parts / spares, other contaminated materials such as rags, and chemicals. • Control adherence to proper cleanup procedures after accidental spills or contamination of the soil.	Operational Phase	• Water quality from surface run-off • No ad hoc servicing of vehicles.
Groundwater Monitoring			
4.	• Monitor the groundwater quality for indications of contamination originating from hydrocarbon and chemical spills during the construction of surface infrastructure, installation of bored piles, and installation of the water supply wells. The quality guidelines include: - WBG EHS Guidelines for Nitrogenous Fertilizer Production (International Finance Corporation, 30 April 2007). - Nigerian Standard for Drinking Water Quality (Standards	Pre-Construction and construction phase. Monthly groundwater monitoring during construction phase.	• Yield and water levels in private / community wells not affected.

Ref No.	Monitoring Measure	Timing and Frequency	Target / Performance Indicator
	• Monitor the depth of excavation during construction of surface infrastructure and restrict it to above the groundwater table where possible. • The handling and storage of chemicals and hazardous material will be monitored and controlled. Chemicals and hazardous materials will be stored in appropriately designed and managed containment areas or containers. • Positioning and design of the water supply wells will be coordinated by a competent hydrogeologist to ensure minimum risk of saltwater intrusion. • The groundwater abstraction from each water supply well will be managed to minimise the vertical drawdown of the groundwater level within each well. The abstraction schedule as designed by a competent hydrogeologist based on proper aquifer testing data will be implemented and recorded. The recorded data will be included in a groundwater monitoring report that comply with the requirements for submittal the authorities. • The change in groundwater levels on site in response to the groundwater abstraction will be monitored. Monitoring wells will be installed in the area between the water supply wells and the Bonny Channel to monitor the groundwater levels. These wells will also be used to monitor the groundwater quality for saltwater intrusion from the Bonny Channel. • A groundwater quality monitoring program should be implemented to monitor the groundwater quality for indications of contamination originating from the use of saltwater that is taken from the Bonny Channel, as fire water. • A groundwater quality monitoring program will be implemented to monitor the groundwater resource for indications of contamination originating from the sewage infrastructure. Indicators for sewage contamination include faecal indicator bacteria, including coliform bacteria, *Escherichia coli* (E.Coli), *Enterococcus* and *Streptococcus* spp.		

Ref No.	Monitoring Measure	Timing and Frequency	Target / Performance Indicator
5.	• A groundwater quality monitoring program will be implemented to monitor the groundwater quality for indications of contamination originating from the transport, off-loading, handling, storage, and loading for export, of urea and ammonia. The groundwater quality will be analysed for the presence of contaminant indicators, increasing trends in the indicator parameters, and compared to the relevant water quality standards. Where elements exceed the quality guidelines, or where increasing trends are identified, management and mitigation should be explored and implemented. The quality guidelines include: - WBG EHS Guidelines for Nitrogenous Fertilizer Production (WBG, 30 April 2007). - Nigerian Standard for Drinking Water Quality (Standards Organisation of Nigeria, 2015). • The handling and storage of chemicals and hazardous material will be monitored and controlled. Chemicals and hazardous materials will be stored in appropriately designed and managed containment areas or containers. • A groundwater quality monitoring program will be implemented to monitor the groundwater quality for indications of contamination originating from the use of saltwater that is taken from the Bonny Channel, as fire water. • A groundwater quality monitoring program will be implemented to monitor the groundwater resource for indications of contamination originating from the sewage infrastructure. Indicators for sewage contamination include faecal indicator bacteria, including coliform bacteria, Escherichia coli (E.Coli), Enterococcus and Streptococcus spp. • The groundwater abstraction from each water supply well will be managed to minimise the vertical drawdown of the groundwater level within each well. The abstraction schedule	Operational Phase. Quarterly groundwater monitoring during operation phase.	• Water quality results compliant to performance criteria • Contaminant indicators include nitrite nitrate (NO_3), and ammonia (NH_3

Ref No.	Monitoring Measure	Timing and Frequency	Target / Performance Indicator
	as designed by a competent hydrogeologist based on proper aquifer testing data will be implemented and recorded. The recorded data will be included in a groundwater monitoring report that complies with the requirements for submittal the authorities. • The change in groundwater levels on site in response to the groundwater abstraction will be monitored. Monitoring wells installed during the construction phase in the area between the water supply wells and the Bonny Channel will be used to monitor the groundwater levels. These wells will also be used to monitor the groundwater quality for saltwater intrusion from the Bonny Channel.		
	Surface Water Monitoring		
6.	• The area and depth of dredging will be monitored to ensure minimum disturbance of the river channel bed. • Construction of the surface infrastructure will be monitored to ensure footprint areas that could increase surface runoff into the Bonny Channel are minimised. As built areas (location and size) will be recorded. • Construction and maintenance of stormwater management infrastructure will be monitored to ensure optimal operation. • Monitoring wells installed during the construction phase in the area between the water supply wells and the Bonny Channel will be used to monitor the groundwater quality for saltwater intrusion from the Bonny Channel. • Monitor the number of vehicles and vehicular movement on site to limit soil erosion and hydrocarbons spills that could impact the river water quality during installation of the bored piles, construction of the surface infrastructure, and installation of the water supply wells. • Storage of chemicals and hazardous materials in appropriately	Pre-construction and construction phase. Monthly surface water monitoring at the sites included in the baseline study during construction phase.	• Volume of dredged spoil • Surface water quality

Ref No.	Monitoring Measure	Timing and Frequency	Target / Performance Indicator
	designed and managed containment areas or containers will be monitored. • Monitor surface soil erosion that could increase the sediment load in the Bonny Channel during and after rainfall events. • Record and control handling, storage and proper disposal of oil, cleaning fluids, used parts / spares, other contaminated materials such as rags, and chemicals that could impact the river water quality. • Control adherence to proper cleanup procedures after accidental spills that could enter the Bonny Channel.		
7.	• The area and depth of maintenance dredging will be monitored to ensure minimum disturbance of the river channel bed. • Maintenance of storm water management infrastructure will be monitored to ensure optimal operation. • Monitoring wells installed during the construction phase in the area between the water supply wells and the Bonny Channel will be used to monitor the groundwater quality for saltwater intrusion from the Bonny Channel. • Monitor the number of vehicles and vehicular movement on site to limit soil erosion and hydrocarbons spills that could impact the river water quality. • Storage of chemicals and hazardous materials in appropriately designed and managed containment areas or containers will be monitored. • Monitor surface soil erosion that could increase the sediment load in the Bonny Channel during and after rainfall events. • Record and control handling, storage and proper disposal of oil, cleaning fluids, used parts / spares, other contaminated materials such as rags, and chemicals that could impact the river water quality. • Control adherence to proper cleanup procedures after accidental spills that could enter the Bonny Channel.	Operational Phase Quarterly surface water monitoring at the sites included in the baseline study during operation phase.	• Water quality for stormwater • Number of clean-up activities at Bonny Channel

Ref No.	Monitoring Measure	Timing and Frequency	Target / Performance Indicator
	Terrestrial Biodiversity Monitoring		
8.	• Aligned to the waste-management plan (Section 7.5.1)- and air quality plan (Section 7.2.1), continually monitor emission levels, dust levels and areas prone to chemical and hydrocarbon spills to enable timeous mitigations. • Inspect all bare areas on and adjacent to the Project footprint for signs of accelerated erosion, especially after high rainfall events to allow immediate mitigation to limit damage. • Monitor all disturbed areas and potential temporary stockpiles of topsoil and/or subsoil at least on a monthly basis for the emergence of undesirable alien invasive plants and eradicate immediately to prevent production of regenerative material. • A Biodiversity Management Plan (BMP), including a Biodiversity Monitoring Program, must be drafted at the latest by the time the pre-construction has been completed, and be revised every 5 years. The same monitoring measures are recommended during the operational phase of the Project. • The BMP will need to also include faunal monitoring, especially where species choose to roost or otherwise 'more permanently use' the Project site to ensure the compatibility of such with Project operations, prioritising the safety of indigenous fauna. • All revisions to the BMP need to take all incident registers during the preceding 5 years into account, with emphasis to any unforeseen event that may have occurred, ensuring biodiversity management keeps on being fully aligned to all existing and potential challenges and/or threats of Project operations to local biodiversity.	Construction and operational phases	• No deterioration in present terrestrial ecological state attributed to construction of the proposed Project.
	Aquatic Biodiversity Monitoring		
9.	• Baseline, pre-construction surveys for underwater noise levels and levels of light at night should be undertaken to provide a baseline against which future changes and impacts can be	Construction and operational phases	• No deterioration in aquatic present ecological state attributed to construction of the proposed Project.

Ref No.	Monitoring Measure	Timing and Frequency	Target / Performance Indicator
	bench marked. • Monitoring should be undertaken to confirm the implementation of mitigation measures, particularly with regards to dredging, underwater noise, and artificial light at night. • The dry season surveys of local waterbirds has been undertaken during month of January 2024, to determine the diversity and abundance of these birds. Once construction has commenced, quarterly surveys should be undertaken to monitor for changes in waterbird communities in the vicinity of the Project, following a before-after-control-impact (BACI) approach. If an effect if observed, adaptive management informed by monitoring results must be implemented. • Following construction, any rehabilitated areas should be monitored for the presence of alien species, which should be removed. • Marine Mammal Observers should be employed during loud noise-producing underwater construction activities such as pile driving. Should marine mammals be sighted, underwater construction should be paused until the mammals have left the area.	Quarterly water birds survey during construction	
Social Monitoring			
Community Health, Safety and Security			
10.	**Health Surveillance and Monitoring System**: To record Project workers 'health details, identifying actions or follow-up where necessary, and the type of healthcare that is being sought. This information will be used to identify the emergence of any health concerns or trends, which need to be proactively managed. Records	Throughout construction Data should be reviewed yearly	• Number of cases of communicable diseases in total and by disease. • Number of cases of vector borne diseases in total and by disease. • Number of cases of STIs in total and by disease. • Number of cases of Diarrhoeal diseases.

Ref No.	Monitoring Measure	Timing and Frequency	Target / Performance Indicator
	will be kept strictly confidential.		• Number of cases referred for treatment at other health facilities. • Number of cases of any new or novel diseases in the area. • Percentage of workers that have received pre-employment health screening.
11.	**Health Education and Training Database**: To record details of the health, education and training provided to Project workers and other stakeholders. This information will be used to determine the success of the training and the need to amend training and information in light of diseases, which are occurring.	Quarterly throughout construction	• Records of training topics delivered. • Records of attendees by grade and location with aim of 100% of workers receiving training.
12.	**Traffic Database**: The Project needs to demonstrate that drivers are being trained and acting in accordance with the measures outlined in this plan. This should include recording accidents or non-compliance related to traffic and training provided to workers and collaborating with local communities on traffic education.	Annual throughout construction	• Number of drivers trained. • Number of community members/ stakeholders engaged with on road safety. • Number of RTAs involving Project vehicles. • Number of incidences of speed exceedances. • Number of vehicles that fail inspections for roadworthiness.
13.	**Grievance Mechanism**: Will log all grievances, issues and concerns raised. The system will also include areas to record information on actions required to address issues, timeframes, personnel responsible and any subsequent feedback that is required.	Quarterly throughout construction	• Number of grievances received related to Community Health, Safety and Security through the Project Grievance Mechanism. • Percentage of grievances resolved within 60 days unless longer timeframes have been agreed due to complexity.

Ref No.	Monitoring Measure	Timing and Frequency	Target / Performance Indicator
14.	**Stakeholder Engagement Database**: Will be used to track and record the dates, minutes, and attendance at engagement activities. In addition, the database will be used to log relevant stakeholders and contact details. Actions agreed along with timeframes will also be logged and tracked.	Quarterly throughout construction	• Number of stakeholder engagement meetings held with stakeholders where community health, safety and security issues are discussed as part of stakeholder engagement activities. • Number of actions from stakeholder meetings closed within 60 days unless longer timeframes have been agreed.
Employment and Procurement			
15.	**Recruitment and Procurement**: The Project needs to demonstrate it is meeting commitments in relation to local employment and procurement for skilled, semi-skilled and unskilled workers using fair and transparent procedures.	Quarterly throughout construction	• Percentage of the skilled, semi-skilled and unskilled workforce hired from within the relevant affected Location and Rivers State. • Percentage of skilled, semi-skilled and unskilled workforce hired from within Nigeria. • Percentage of procurement of goods and services from affected Locations and Nigeria respectively. • Zero hiring / procurement at the gate.
16.	**Occupational Health and Safety (OHS)**: The OHS system will include a variety of plans and procedures depending on the activities being undertaken and associated risks. Staff will also receive training on this, and incidents and accidents recorded and investigated. Implementation of the OHS system will be monitored to ensure that it is being implemented appropriately and that risks are being managed. This will include regular (daily) site walkovers to observe behaviors and more detailed weekly checks of performance. Accident and incident data will be reviewed monthly to spot trends	Monthly throughout construction	• Percentage of workers (direct employees, contractors, and subcontractors) that have received OHS induction prior to working on site. • Number of workers (direct employees, subcontractors, and suppliers) that have received task specific training. • Percentage of workers attending toolbox talks. • Number of stop work notices issued by activity.

Ref No.	Monitoring Measure	Timing and Frequency	Target / Performance Indicator
	where further health and safety measures or training may need to be implemented.		• Number and type of non-compliances observed during daily and weekly site inspections. • Percentage of workers that receive PPE (without payment). • Zero fatalities involving workers on site. • Number of Lost Time Incidents involving workers on site. • Number of minor incidents and injuries. • Number of incidents investigated, corrective actions identified and closed out/ not closed out within the required timeframe.
17.	**Retrenchment Plan**: The Project needs to monitor implementation and compliance to demonstrate workers have been provided with assistance to find alternative incomes following construction such that their livelihoods are improved.	Six months after significant retrenchment of workers	• Percentage of workers that receive training or other support identified. • Percentage of work who receive all documentation (references, final pay, certificates etc.) upon completion of their contact.
18.	**Supplier and Subcontractor Management**: The Project needs to monitor the performance of suppliers and subcontractors in relation to labour and working conditions to ensure workers' rights are being protected. Where issues are identified the Project needs to work with the supplier or subcontractor to develop remedial action	Annual throughout construction (depending on size of the contract)	• Percentage of suppliers and subcontractors hired where assessment has identified issues associated with forced labour, child labour or significant safety violations. • 100% of contracts including clauses on labour and working conditions in line with Nigerian Law and the IFC PS2. • Number of issues (non-conformities) not closed out in the agreed timelines. • Number of suppliers/ contractors removed from the Project due to failure to address non-conformities.

Ref No.	Monitoring Measure	Timing and Frequency	Target / Performance Indicator
19.	**Workers' Rights**: The Project needs to monitor that workers' rights are being respected in line with the requirements of Nigerian Law and IFC PS2 related to: working conditions, discrimination, equal remuneration, freedom of association, forced labour, child labour, grievance mechanism and worker accommodation (where provided).	Quarterly throughout construction	• Percentage of workforce who receive training/ induction on HR policies, plans and procedures. • Percentage of workforce who are women or from other vulnerable groups. • 100% of workers having contracts in line with Nigerian Law. • 100% of workers having received information on their rights and responsibilities, as enshrined in law and IFC PS2. • Average number of hours worked per week. • Average number of days worked without a rest day (excluding rotational workers) • Average number of overtime hours worked per week. • Number of casual or day workers hired. • Percentage of workers that have joined a union or workers forum to raise issues. • Number of meetings of workers forums per quarter. • Percentage of workers who are covered by a collective bargaining agreement. • Number of incidences of forced or child labour within direct employees, subcontractors, and suppliers. • Monthly inspections of all accommodation provided completed. • Number of non-compliances identified related to accommodation • Number of non-compliances not closed out within 14 days. • Number of workers (direct employees

Ref No.	Monitoring Measure	Timing and Frequency	Target / Performance Indicator
			and subcontractors) trained on the worker grievance mechanism. • Percentage of grievances resolved within 60 days (or agreed longer timescales where relevant). • Number of grievances received by theme. • Number of grievances from workers or job seekers related to discrimination, abuse of labour rights, sexual harassment.
	Waste Monitoring		
20.	• Waste contractors will be audited to ensure that facilities and waste disposal/treatment/recycling / reclamation processes are suitable and in line with national Nigerian and international good practice standards.	At the start of construction	• Waste contractor facilities and process fully licensed and performance is in line with local and international requirements.
21.	• Housekeeping checks will be conducted to ensure waste is being transferred to and stored correctly and that no littering is occurring at active work sites.	Visual inspections on an *regular* basis	• Well-maintained and clean active work areas that are free of litter and other wastes.
22.	• Regular Inspections of waste disposal areas at active work areas and waste storage facilities will be undertaken to ensure compliance with this ESMMP, Environmental Licence conditions and relevant legislation.	Visual inspections on an *regular* basis	
23.	• A complaints register will be maintained detailing complaints about waste management.	Throughout construction	• Up to date complaints register.
24.	• A record will be maintained of all impacts to health that are potentially attributable to waste management.	Throughout	• Up to date record.

Ref No.	Monitoring Measure	Timing and Frequency	Target / Performance Indicator
		construction	
	Spill Monitoring		
25.	• Weekly inspections where any missing response equipment, personal protection equipment, or documentation will be replaced or improved as necessary.	Weekly throughout construction	• No missing response equipment, personal protection equipment or documentation.
26.	• Quarterly reporting to identify any upcoming required preventative maintenance required, as well as what preventative maintenance was performed the previous quarter.	Quarterly throughout construction	• Well implemented preventative maintenance programme.
27.	• Bi-annual spill response drill to provide information regarding required revisions to training or the ESMMP.	Bi-annual throughout construction	• Undertaking bi-annual spill response drills.
28.	• All spills and associated control and containment measures taken will be recorded and the effectiveness of response will be audited.	Throughout construction	• Spill log maintained and up to date with corrective actions closed out.
	Cultural Heritage Monitoring		
29.	• Tracking of all Cultural Heritage finds from discovery through development and implementation of treatment plans.	Throughout construction	• Verifiable tracking system maintained and up to date.
30.	• Continued recording and documentation of all cultural heritage finds	Throughout construction	• Well maintained records/documentation of chance finds
31.	• Periodic auditing of all training records for contractors and company staff on cultural awareness	Bi-annual throughout	• Bi-annual training records on cultural heritage awareness

Ref No.	Monitoring Measure	Timing and Frequency	Target / Performance Indicator
		construction	

Appendix – B

Environmental and Social Impact Assessment for the Proposed MM FZE Port at Federal Ocean Terminal, Onne Port Complex, Onne, Rivers State

Stakeholder Engagement Plan

CONTENTS

ACRONYMS AND ABBREVIATIONS

Acronyms	Description
AoI	Area of Influence
CR&D	Community Relations and Development Department
EAD	Environmental Assessment Department
EIA	Environmental Impact Assessment
EPA	Environmental Protection Agency
ESIA	Environmental and Social Impact Assessment
FMENV	Federal Ministry of Environment
GMP	Grievance Management Procedure
HR	Human Resources
IFC	International Finance Corporation
IFC PSs	International Finance Corporation Performance Standards on Environmental and Social Sustainability
IFT	Industrial Training Fund
IR	Industrial Relations
KPI	Key Performance Indicator
LGA	Local Government Area
MM FZE	Meliora Methanol Free Zone Enterprise
MOU	Memorandum of Understanding
MTPA	Million Tonnes Per Annum
MTPD	Metric Tons Per Day
NESREA	National Environmental Standards and Regulations Enforcement Agency
NSITF	Nigeria Social Insurance Trust Fund
PAYE	Pay As You Earn (Tax)
SEP	Stakeholder Engagement Plan
NNPC	Nigeria National Petroleum Company

1. INTRODUCTION

This Stakeholder Engagement Plan (SEP) has been developed specifically for the Environmental and Social Impact Assessment (ESIA) associated with the proposed Meliora Methanol Port Free Zone Enterprise Facility at Federal Ocean Terminal, Onne Port Complex, Onne, Rivers State (hereafter referred to as the Project or MM FZE Port Facility). Moreover, it provides an implementation framework for post-ESIA engagement (i.e., from the remainder of the feasibility and permitting phases, through construction, operation, and decommissioning). The SEP seeks to define a technically and culturally appropriate approach to consultation and disclosure. The SEP seeks to ensure that adequate and timely information is provided to stakeholders, and that these groups are given sufficient opportunity to voice their opinions and concerns, which in turn will have a positive influence on Project execution.

The SEP is a working document that will be updated and adjusted as required during Project development and execution.

This SEP draws reference to the following existing Project documentation pertaining to stakeholder engagement:

- Indorama Corporation Group Handbook (Version 2, 18 July 2022)
- Social Impact Assessment and Stakeholder Engagement Plan for MM FZE Port Facility Project
- Stakeholder / Community Grievance Management Procedure 25th April 2018
- Local Hiring Plan for Construction & Operation phase of MM FZE Port Facility Project
- Report on Stakeholder Engagement done during ESIA Process of MM FZE Port Facility Project
- Procedural Manual Social Material Topics
- Guidelines for prevention and addressing issues of Retaliation
- Policy Guidelines on Gender Based Violence & Harassment

1.1 PURPOSE

The aim of the SEP is to describe how the Project will engage external stakeholders during the ESIA process, pre-construction, construction, operations, and decommissioning phases. It demonstrates the commitment of the Proponent to an ‘international best practice’ approach to stakeholder engagement. MM FZE Port Project is committed to full compliance with the Nigerian Environmental Impact Assessment (EIA) Regulations, which includes the Environmental Impact Assessment Act, No. 86 of 1992, amended as EIA Act CAP E12, LFN 2004. In addition, the MM FZE Port Project will align with the International Finance Corporation Performance Standards on Environmental and Social Sustainability, 2012 (IFC PSs).

In line with current international best practice, this SEP aims to ensure engagement that is free of manipulation, interference, coercion, and intimidation.

To this end, this SEP provides the following:

- Requirements for consultation and disclosure;
- Identification and prioritisation of stakeholders;

- Strategy and timetable for sharing information and consulting with stakeholders;
- Identification of structures and processes to deal with conflicts and grievances; and
- Resources and responsibilities for implementing stakeholder engagement activities.

1.2 OBJECTIVES

The objectives of this SEP are as to:

- Understand the interests, influence, and concerns of various Project stakeholders.
- Ensure effective, transparent, and timely communication between the Project and its stakeholders, to engender an environment of trust and mutual respect.
- Engage stakeholders on their concerns regarding the Project, and appropriately address these through dialogue and corrective actions.
- Establish effective means of communication to disseminate information from the Project to stakeholders.
- Design stakeholder engagement mechanisms and standards that respect local traditions and cultural norms.
- Effectively manage the expectations of stakeholders regarding socio-economic benefits derived from the Project.
- Establish the appropriate management mechanisms and identify necessary capacity building and training requirements for the effective implementation of the SEP.

1.3 PROJECT DESCRIPTION

The Project involves the construction of a new urea and ammonia export facility. The new terminal will be at Onne, Nigeria about 20 km away from Indorama's existing manufacturing site in Port Harcourt (refer to Figure 1-1). The terminal will have one berth with the capacity to handle and export 1.4 Million Metric Tons per Annum (MMTPA) of granulated Urea and about 150 Kilo Tons per Annum (KTA) (approximately 420 MTPD) of Ammonia. Besides the quay, the Terminal shall consist of urea storage and handling systems, ammonia storage and handling systems and associated facilities. The terminal shall be constructed on a plot having waterfront access of approximately 400 meters at the Federal Ocean Terminal at Onne.

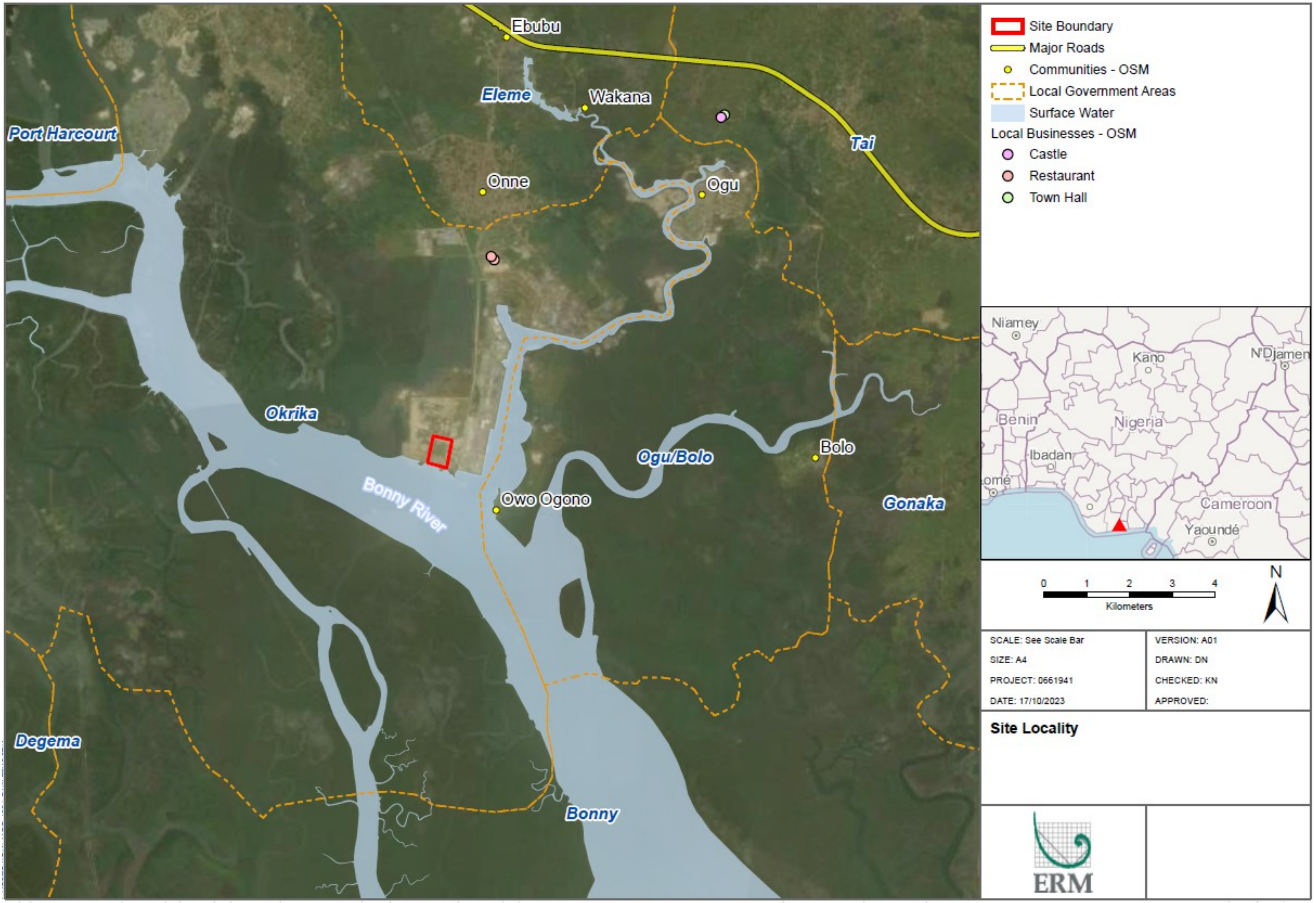


FIGURE 1-1 PROJECT LOCALITY MAP

1.4 STRUCTURE OF THE SEP

The remainder of this Document is structured as follows:

Section 2: Legal Framework

Section 3: Principles of Engagement

Section 4: Project Stakeholders

Section 5: Summary of Previous Engagement

Section 6: Organisational Capacity

Section 7: Stakeholder Engagement Plan

Section 8: Reporting, Monitoring, and Evaluation

Section 9: Grievance Management Procedure (GMP)

2. LEGAL FRAMEWORK

2.1 NIGERIAN LEGISLATIVE REQUIREMENTS

The Nigerian EIA Act, No. 86 of 1992 (as amended in 2004 and regulations revised in 2021) requires that an EIA[1] is undertaken for all public and private development projects. The Act divides projects into three categories:

- Category 1 projects that require a full and mandatory EIA.
- Category 2 projects that require a partial EIA.
- Category 3 projects that are deemed as beneficial to the environment and therefore require no EIA.

According to the EIA regulations, "Public Participation should be seen as a continuous programme for the environmental and economic sustainability of the project." Public entry points into the EIA process are contained in the following four distinct stages of the EIA:

1. A scoping workshop is required during the scoping phase, especially if public interest in the project is high, and is required to include key stakeholders.
2. Stakeholders are required to be involved in the EIA drafting process, where "proceedings of consultations with adjoining communities and other stakeholders held in a Public Forum/Focal Group Discussions (FGD)/interview etc. (Public Participation)" are to be submitted with the draft EIA. This includes surveys which may be conducted to determine the social baseline and capture stakeholder comments on the project.
3. During the review of the EIA, it may be required that EIA documents are disclosed publicly for 21 days. Disclosure points should include, at a minimum, the Local Government Area offices, the state Ministry of Environmental or Protection Agency Offices, and the Federal Ministry of Environment Headquarters and Zonal offices. Other disclosure locations should be considered as appropriate. Project-affected communities should be invited to participate in the review process through newspaper advertisements and radio announcements.
4. If the project is classified as Category 1, the public is invited to comment on the project during a public hearing/panel review.

2.2 INTERNATIONAL REQUIREMENTS

The following Section sets out the engagement-specific requirements aligning to international good practice standards.

2.2.1 THE INTERNATIONAL FINANCE CORPORATION PERFORMANCE STANDARDS ON ENVIRONMENTAL AND SOCIAL SUSTAINABILITY, 2012 (IFC PSS)

The IFC PSs are considered a benchmark for good practice on environmental and social (E&S) risk and impact management in private sector developments. The IFC PSs require that clients engage affected communities through disclosure of information, consultation,

[1] Nigerian regulations refer only to an Environmental Impact Assessment, or EIA. Given that the impact assessment conducted for the Project has been aligned to the IFC Performance Standards, the assessment documents are referred to as an Environmental and Social Impact Assessment (ESIA) in the remainder of this SEP to better reflect the contents of the impact assessment.

and informed participation, in a manner proportional to the risks to and impacts of the project on the affected communities.

The IFC PSs include specific guidance on conducting stakeholder engagement both during the planning phase and throughout the project lifecycle.

Stakeholder engagement requirements are contained in PS 1: Assessment and Management of E&S Risks and Impacts. The key requirements for consultation and disclosure through the life of the Project are summarised in Box 2.1.

BOX 2.1 REQUIREMENTS FOR STAKEHOLDER ENGAGEMENT IN IFC PS 1

Aims:
To ensure that affected communities are appropriately engaged on issues that could potentially affect them; to build and maintain a constructive relationship with communities; and to establish a grievance redress mechanism.

Who to Consult:
Specifically with:
- Directly and indirectly affected communities;
- Positively and negatively affected communities/individuals;
- Those with influence due to local knowledge or political influence;
- Elected representatives;
- Non-elected community officials and leaders;
- Informal/traditional community institutions and/or elders;
- Indigenous peoples, where the Project is identified to have adverse impacts on them;
- Non-Governmental Organisations (NGOs) and community-based organisations (CBOs);
- Key interest groups; and
- Communities in the wider area of influence (AoI).

When to Consult:
As early as possible, or at the latest consultation should begin prior to construction. Consultation should be an on-going process throughout the life of the Project, i.e., iterative. Consultation should also allow for a feedback mechanism where affected people are able to present their concerns and grievances for consideration and redress.

What to Consult on:
Disclosure of Project information (purpose, nature, scale);
- Disclosure on the E&S Action Plan as a result of consultation, with periodic reports to demonstrate implementation;
- Risks and impacts of the Project; and
- Updates actions and proposed mitigation measures to address negative impacts and areas of concern for affected communities.

How to Consult:
Consultation should:
- Be inclusive and culturally appropriate;
- Allow for free, prior and informed participation of affected communities;
- Be in the language preferred by the affected communities;
- Consider the needs of disadvantaged and vulnerable groups;
- Be fed into the decision-making process including proposed mitigation, sharing of benefits and opportunities;
- Be iterative;
- Be documented;
- Be responsive to community concerns and grievances;
- Be easily understood and transparent; and
- Allow for differentiated means of engagement particularly for disadvantaged or vulnerable groups.

** Where engagement relies substantially upon a community representative the client will aim to ensure that the views of affected communities are communicated, and that the results of consultation are communicated back to the community.*

Source: IFC Performance Standard 1, (paragraphs 25-35)

3. PRINCIPLES OF ENGAGEMENT

The key principles guiding the Project's approach to stakeholder engagement are as follows:

- **Transparency:** to be open and transparent with stakeholders.
- **Accountability:** to be willing to accept responsibility as a corporate citizen and to account for impacts associated with the Project activities.
- **Trust:** to have a relationship with stakeholders that is based on mutual commitment to acting in good faith.
- **Mutual Respect:** to respect stakeholders' interests, opinions, and aspirations.
- **Collaboration:** to work cooperatively with stakeholders to find solutions that meet common interests.
- **Responsiveness:** to coherently respond in good time to stakeholders.
- **Proactiveness:** to act in anticipation of the need for information or potential issues.
- **Fairness:** to engage with stakeholders such that they feel they are treated fairly, and their issues and concerns are afforded fair consideration.
- **Accessibility:** to be within reach of stakeholders so that they feel heard and to provide meaningful information as needed.
- **Inclusivity:** to proactively anticipate, identify and include all stakeholders.

These principles have informed the Project's approach to stakeholder engagement.

4. PROJECT STAKEHOLDERS

To develop an effective SEP, it is necessary to identify Project stakeholders and understand their interest, priorities, and objectives in relation to the Project. For the purposes of this SEP, a stakeholder is defined as ***any individual or group who is potentially affected by the Project, or who has an interest in the Project and its potential impacts***.

By classifying and analysing the influence and support of various levels of stakeholders, it is possible to develop a Plan that is tailored to the needs of different stakeholder groups. It is also important to understand how each stakeholder may be affected by the Project (or perceives they may be affected by the Project) so that engagement can be tailored to address their views and concerns in an appropriate manner.

4.1 STAKEHOLDER IDENTIFICATION AND MAPPING

4.1.1 EXTERNAL CONTEXT

The Project is located within the Onne Port complex is situated on the Bonny River, approximately 25 km southwest of Port Harcourt, Rivers State, Nigeria. The Onne Port Complex was established as a ‘Free Port Zone’ to serve as the focal point for the oil and gas industry in West Africa. This complex, which started in 1982 as the Federal Lighter Terminal, has grown over the years into one of the largest Oil and Gas Free Zones in the world, due largely to Public/Private Partnerships.

The Onne community of Eleme LGA and the Ogu community of Ogu-Bolo LGA are the host communities of this port complex. Ogu-Bolo has an area of 125.3 km^2 with a population of 75,282 and population density of 864.4 per km^2. Eleme has an area of 150.1 km^2 with a population of 190,194 and population density of 1,823 per km^2. From the 1991 to the 2006 census, both LGA showed a 2.3% annual population growth rate which was slightly lesser than Rivers State population growth rate (2.85%).

Indorama operates an existing port terminal “OIS Indorama Port Limited” for Urea export which is located within Onne Port Complex. The key community stakeholders for this entity are Onne and Ogu. As the proposed Project site is within Onne Port Complex, the same communities (Onne & Ogu) are considered for socio-economic and cultural heritage survey and for further engagements.[2]

4.1.2 ENVIRONMENTAL IMPACT ASSESSMENT AND AREA OF INFLUENCE

For the purposes of undertaking a socio-economic impact assessment as part of the Project ESIA, a social area of influence (AoI) has been determined for the Project. This AoI has been divided into two components, a social area of direct impact with a 2 km radius, and a social area of indirect impact within a 10 km radius. Onne and Ogu form the two main communities in the AoI. Owo Ogono and Ele, both sub-communities of Ogu, are nearest to the Project site, at a distance of 1.4km and 2.5km respectively. Onne town centre is 5,7km away, while Ogu town centre is 8.2km away. Refer to Figure 4-2 for an overview of the Project’s social AoI.

[2] Socio-Economic and Cultural Heritage Report for MM PORT FZE Project ESIA, MM FZE 2023

4.1.3 STAKEHOLDER IDENTIFICATION

To undertake effective engagement, it is necessary to identify Project stakeholders and understand their interest, priorities, and objectives in relation to the Project.

Table 4-1 presents the stakeholders currently identified for the Project.

FIGURE 4-2 HOST COMMUNITIES

TABLE 4-1 STAKEHOLDER IDENTIFICATION[3]

Stakeholder Category	Stakeholder Groups	Stakeholders	Connection to Project
Government	• Federal Ministry of Environment • Rivers State Ministry of Environment • Nigerian Ports Authority • Rivers State Ministry of Chieftaincy and Community Affairs • Eleme Local Government • Ogu-Bolo Local Government	• Director, Environment Assessment Department, Federal Ministry of Environment • Director, Pollution Control & Environment Health Department, Federal Ministry of Environment • Rivers State Commissioner of Ministry of Environment • Director, Pollution Control Department, Rivers State Ministry of Environment • Director, Environment Assessment Department, Rivers State Ministry of Environment • Rivers State Commissioner of Chieftaincy & Community Affairs • Supervisor to Environment, Eleme Local Government • Supervisor to Environment, Ogu-Bolo Local Government	Environmental Regulatory bodies are of primary importance in terms of establishing policy, granting permits or other approvals for the Project, and monitoring and enforcing compliance with Nigerian law throughout all stages of the Project life cycle. Regional and Local Governments may input into the permitting process and may have a role in monitoring the implementation of Project commitments included in the ESMP.
Traditional Rulers and Community Leaders	• Onne Traditional Leaders • Ogu Traditional	• Paramount Ruler of Onne • Paramount Ruler of Ogu	Local community leaders as representatives of their local community. Traditional rulers play vital role in community development, civil administration, and socio-economic wellbeing in their domain by

[3] A full database of all stakeholders should be maintained separately from the SEP and should be updated as new stakeholders are identified, or at least on an annual basis.

Stakeholder Category	Stakeholder Groups	Stakeholders	Connection to Project
	Leaders • Clan Heads • Community Development Committees		interfacing with the government. Traditional rulers are custodians of cultures, customary territorial rights, and privileges of people in their communities. Traditional rulers preside over civil and customary grievance / dispute resolution processes. Traditional rulers represent and protect the socio-economic interest of the communities before government and external agencies. Traditional rulers participate in Public Forum discussions and Technical Panel review as part of ESIA. Traditional rulers' interface with MM FZE for community development projects, other CSR activities and its implementation. Management of communication in the communities with respect to Project.
Directly Impacted Communities	• Communities within close proximity of the proposed port facility[4]	• Onne community • Ogu community • Community development committees	• Oil & Gas Free Zone Area (OGFZA) was established by Section 2 of the Oil and Gas Export Free Zone Act No. 8 of 1996 to regulate Nigeria's Oil and Gas free trade zones. The Authority began operation in Onne, Rivers State in 2001. However, there will be social, environmental, and economic impacts connected to Project construction and operation of Port Terminal facility. • Community Development Committees are entrusted with the responsibility to interface with the company on behalf of communities for the following: • Participation in ESIA Public forums to discuss positive / negative impacts of the Project and the mitigation measures. • Participation in ESIA Technical Panel review to observe the evaluation process of mitigation measures set out to address the adverse impacts be social / economic / environmental impacts by experts and regulatory authorities. • Manage communications in the communities regarding the outcome of public forums and technical panel review.

[4] Indorama will ensure that engagement with communities within the AoI will be commensurate with risks and impacts experienced. Indorama should include procedures to ensure that sub-communities in closer proximity to the site or experiencing greater negative impacts are appropriately engaged through existing local structures.

Stakeholder Category	Stakeholder Groups	Stakeholders	Connection to Project
			• Agreements and communiques • Monitoring implementation of agreements / communiques for the following: o Community Development Projects o Contracts and supplies o Employment during construction and operation phase. o Scholarship programmes for youth studying in universities. o Micro Grant for women for micro business o Skill development programme for young men and women.
Vulnerable Groups	• Women • Youth	• Onne Women Leaders • Ogu Women Leaders • Onne Youth Council • Ogu Youth Council	Women representatives and youth representatives are going to be an integral part of the decision-making process during ESIA public forum, technical panel review, adverse impacts / mitigation measures, agreement, community development projects, employment, skill acquisition programme, subcontracts & supplies, and grievance management process during ESIA / construction / operation phase of the Project.
Employment and Business Associations	• Workers Unions • Employment Forums • Contractors • Oil & Gas Free Zone Area (OGFZA) Joint Community Relations Committee	• Welders and Fitters Association • Indigenous Suppliers Forum • OGFZA – Joint Community Relations Committee	Elected representatives of unions participate in collective bargaining agreements for betterment of condition of service, discussion on betterment of working condition, grievance management process, disciplinary management process, conflict and dispute resolution process during the construction and operation phase of the Project. Elected / nominated members of Indigenous Suppliers represent their members for access to information with regards to contracts, supplies, grievance management dispute / conflict resolutions. Joint Community Relations Committee is a representative forum. Members are nominated by companies who operate in OGFZE to discusses, resolve issues connected with communities and develop an overall CSR strategy.
Civil Society	• Civil Society Organisations (CSOs) • Interest Groups	• Fishers Association • Hunters Association	Civil Society and Interest Groups as representatives of their local community.
Other	• Academia	• Professors / teachers	Linkage between theory and practical through industrial training, new

Stakeholder Category	Stakeholder Groups	Stakeholders	Connection to Project
stakeholders	• Media	• Radio and Print media	skill development and recruitment and funding for research and development. Information from source via direct meeting or site visit, coverage of CSR events via invitation to events

5. SUMMARY OF PREVIOUS ENGAGEMENT

The following stakeholder engagements have been undertaken as part of the ESIA process:

TABLE 5-2 PREVIOUS STAKEHOLDER ENGAGEMENTS

Date	Stakeholder	Purpose
8 December 2022	FMEnv – EA Dept, Team leaders 7 attendees	Discuss proposed Project and draft ToR (Institutional Consultation)
17 January 2023	FMEnv, Rivers State Ministry of Environment (RSMEnv), ECSL & Proponent reps 12 attendees	Site verification required for Project categorization (Institutional Consultation)
12 April 2023	FMEnv, RSMEnv, Eleme LGA, Relevant Stakeholders, ECSL & Proponent reps 47 attendees	Scoping workshop with Onne Community for ESIA, ToR/SoW (Institutional and Public Participation)
13 April 2023	FMEnv, RSMEnv, Eleme LGA, Relevant Stakeholders, ECSL & Proponent reps 36 attendees	Scoping workshop with Ogu Community for ESIA, ToR/SoW (Institutional and Public Participation)
4 July 2023	FMEnv, RSMEnv, ECSL Team Proponent & Community reps 23 attendees	Kick-off meeting for field data gathering exercise to streamline sampling strategy and techniques
11 July 2023	Ogu community stakeholders - Community Chiefs, CDC, Women Leader and Executive, Community Youth President and Executive, Farmers, Traders etc. 20 attendees	Educate participants on the proposed Project scope, environmental, social, economic and health aspects. Possible impacts of the Project and community perspective (expectation, benefits, and perception etc.).
12 July 2023	Onne community stakeholders - Community Chiefs, CDC, Women Leader and Executive, Community Youth President and Executive, Farmers, Traders etc. 20 attendees	Educate participants on the proposed Project scope, environmental, social, economic and health aspects. Possible impacts of the Project and community perspective (expectation, benefits, and perception etc.).

5.1 EXISTING STAKEHOLDER CONCERNS

The following high-level stakeholder concerns have been captured based on those engagements undertaken for the Project to date:

- **Loss of Land**: Deterioration and destruction of natural land and trees/plants from the development of the Project
- **Environmental Impacts**: Negative impacts on the natural environment and biodiversity such as groundwater, surface water, and air pollution.
- **Socio-economic Benefits**: Distribution of employment, procurement, and corporate social investment benefits between communities, and a perceived insufficiency of such interventions given the scale of need in the area.

- **Traffic**: Concern was expressed regarding increased traffic levels traversing through Onne as well as the safety impacts on informal traders.
- **Ongoing Engagement**: A perceived lack of sufficient ongoing engagement between Indorama and host communities.

6. ORGANISATIONAL CAPACITY

This Section sets out the internal capacity commitments that MM FZE Port Facility has in order to achieve successful implementation of stakeholder engagement planning and strategy, and to ensure the overall success of stakeholder management.

6.1 MANAGEMENT STRUCTURE

The organisational structure of the MM FZE Port Project team is presented in Figure 6-3, and further detail on key roles is provided below.

6.1.1 HEAD: HUMAN RESOURCES (HR) AND INDUSTRIAL RELATIONS

- Responsible for Manpower planning and budgeting, recruitment, HR policy framework, organization structure, compensation philosophy and HR processes.
- Management Industrial Relations, Employee Relations, and collective bargaining process.
- Management of employee grievance management and disciplinary procedure.
- Contract Labour Management, policy framework, wage structure and CBA.
- Supervision of community relations and community development (CSR).
- Performance management system, Increments, Promotions. Plan and monitor employee High Potential Development Plan:
    - Career Planning and Development – identification of critical roles and critical talent and management of development plan.
- Training and development- identification of critical capabilities and development, training need identification, annual training calendar, budgeting and planning.
- Organizational Development initiatives: change management, ESG, digitalization of HR processes, job evaluation, employee engagement survey, diversity and inclusion programmes.
- Management global social sustainability performance standards.
- Supervision of employee welfare and administration.
- Statutory compliance – Immigration Law, Penson, Life Insurance, NSITF, ITF, PAYE, Employment Law, etc.
- Overall responsibility for all stakeholder engagement activities.
- Provide sufficient and competent resources, including budget, for effective implementation of the SEP.
- Continuously update stakeholder information (contact details).
- Support the Corporate Communication Department in organizing, sponsoring, and attending events on behalf of MM FZE Facility as required.
- Review performance indicators and issues with the Managing Director and Project Management at Project Stewardship Reviews.
- Elevate issues (as appropriate) should they emerge urgently and outside of Project Stewardship Reviews.

6.1.2 HEAD: COMMUNITY RELATIONS AND DEVELOPMENT

- Build and maintain strong working relationships with key stakeholders and manage stakeholder engagement activities within all communities.
- Communicate with communities, contractors, and subcontractors around Project plans, progress, impacts and benefits.
- Prepare the list of shortlisted community candidates for the Project team to carry out the recruitment process in accordance with HR guidelines.
- Monitor the compliance of local content on a monthly basis from the reports of the Construction Contractor and report the same in the local leadership meetings.
- Identify community needs for social development or engagement requirements and required logistics.
- Act as mediator between company and stakeholders (communities, Government structures, Traditional structures, non-governmental organisations, etc.).
- Champion the implementation and monitoring of the Grievance Redress Process (refer to Section Error: Reference source not found).
- Monitor and prioritize relevant political and social intelligence in the areas of operation for MM FZE Facility and report this information in a timely manner through line management.
- Advise management on the outcomes of stakeholder engagement activities and programs.

Assist the HR during the recruitment process by soliciting community requirements.

6.1.3 COMMUNITY RELATIONS OFFICER

- Provide feedback to the Community Relations and Development Manager on concerns raised by the community and traditional structures.
- Facilitate the internal review of quantitative and qualitative community engagement data.
- Facilitate community engagement meetings across the Project area.
- Assist in the preparation of various reports and publications.

6.1.4 CORPORATE COMMUNICATIONS MANAGER

- Responsible for the disclosure of Project information and public consultation activities.
- Responsible for sustaining relationships and communicating with Government entities and the media.
- Responsible for internal communications with staff and contractors concerning occupational health and safety.
- Participate in all relevant corporate and community events and provide proactive advice, develop and implement plans on engagement and stakeholder matters where needed.

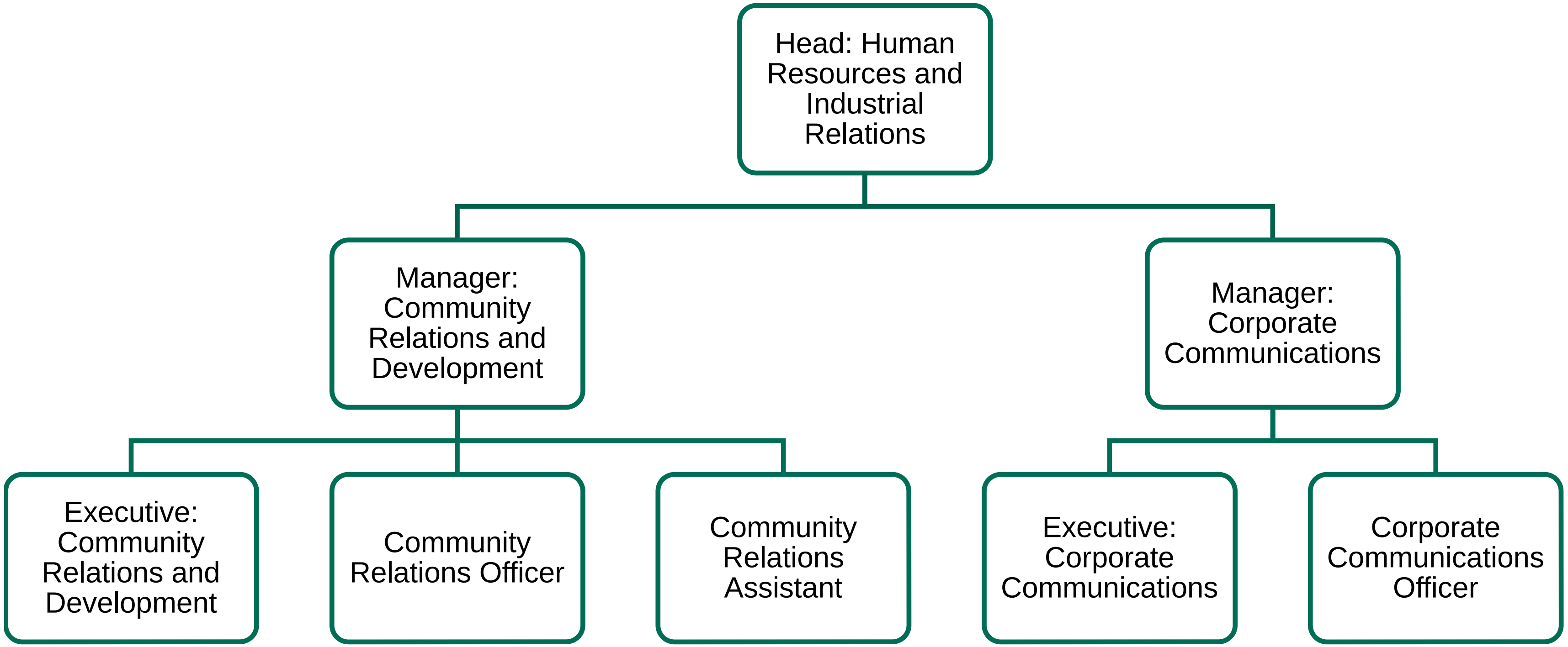


FIGURE 6-3 MANAGEMENT STRUCTURE – STAKEHOLDER ENGAGEMENT

7. STAKEHOLDER ENGAGEMENT PLAN

This SEP covers stakeholder engagement activities for the ESIA and includes a framework for post-ESIA engagement (i.e., pre-construction, construction, operational and decommissioning phases) of the Project.

7.1 ENGAGEMENT PHASES

A summary of all engagement activities is presented in Table 7-3. As the SEP is a working document, this Plan will be updated should the need arise for more intensive engagement with certain stakeholder groups or should there be a substantial change to the Project plan.

TABLE 7-3 STAKEHOLDER ENGAGEMENT PHASES AND ACTIVITIES

Engagement Phase	Engagement Activities
ESIA	Public involvement in scoping workshop
	Further public participation and stakeholder engagement
	ESIA disclosure
	ESIA comment and objection
Pre-Construction	Agreements with Host Communities
	Quarterly engagement with local leadership Community Development Committee (CDC)
	Provide quarterly Project updates
	Engagement with employment and business forums
Construction Phase	Quarterly engagement with local leadership
	Quarterly engagement with CDC
	Monitoring of grievances
Operational Phase	Annual engagement with local leadership
	Provide broader Project updates as required
	Monitoring of grievances
Decommissioning Phase	Announcement of intended decommissioning
	Quarterly engagement with local leadership
	Provide broader decommissioning updates as required
	Monitoring of grievances

7.1.1 ESIA PHASE

This phase involves engagement activities related to the completion of the ESIA process, and subsequent disclosure of the ESIA findings. Engagement activities include:

Public Involvement in Scoping Workshop

As per Nigerian environmental regulations, a public hearing may be requested during the scoping phase to adequately determine the Terms of Reference of the ESIA. This requirement was made known to the MM FZE Port Project by the FMEnv, and the workshop in question was held on 12 and 13th April 2023 with 83 stakeholders that participated.

Further Public Participation and Stakeholder Engagement

Where the ESIA process has identified information gaps or further public participation requirements, these must be addressed by the Project prior to the completion of the ESIA and records and findings should be attached as an addendum to the ESIA document. This should be conducted as per the FMEnv requirements and was conducted on 11 and 12th July 2023 with the Ogu and Onne community.

ESIA Disclosure

Following the completion of the ESIA, findings should be disclosed to all stakeholders. In compliance with the EIA Act, No. 86 of 1992 (amended 2004), once the ESIA is under review by the FMEnv, the ESIA documents may be requested by the FMEnv to be disclosed publicly for 21 days. Locations to display the documents should include:

- Eleme and Ogu-Bolo Local Government Area offices;
- Rivers State Ministry of Environment Offices; and
- The Federal Ministry of Environment Headquarters and Port Harcourt Zonal Office.

ESIA Comment and Objection

The Project must make reasonable opportunity available to stakeholders to comment or object to the ESIA findings. This will be conducted in compliance with EIA Act of 1992 (amended 2004) and will include advertisements in local newspapers and radio announcements to invite the public to participate in the ESIA review process, where necessary. Where the comments or objections are deemed reasonable and eligible, the MM FZE Port Facility will endeavour to address them through an updated Project design or through further engagement with the objecting stakeholders.

7.1.2 PRE-CONSTRUCTION PHASE

This phase outlines engagements that will be undertaken post the ESIA process but prior to the commencement of construction.

Quarterly Engagement with Local Leadership[5]

During the pre-construction phase, the local leadership will receive updates on the progression of planning for construction commencement. The local leadership will play an important role in continually communicating relevant Project information with communities and other stakeholders.

Provide Quarterly Project Updates

The MM FZE Facility will continue to provide feedback and updates to stakeholders regarding the progression of planning for construction commencement, as well as any

[5] In the context of this SEP, local leadership refers to specific mechanisms established by Indorama to facilitate engagement with host communities. This may take form of, for example, project committees or engagement forums.

other pertinent information to be disclosed. This feedback will be provided primarily through local leadership structures, with the option to include broader engagement with traditional and community leaders where this is considered necessary.

Engagement with Employment and Business Forums

Reference should be made to the *Local Hiring Plan for Construction and Operation phase of MM FZE Facility* prior to engaging stakeholders on this issue.

Grievance Management Procedure (GMP)

The Proponent should inform all stakeholders of the Project grievance mechanism, with a particular emphasis on how stakeholders may register grievances with the Project.

7.1.3 CONSTRUCTION PHASE

Provide Periodic Project Updates

Periodic updates regarding the progression of construction, as well as any other pertinent information to be disclosed, will be provided through engagements with traditional and community leaders, as well as youth structures, and any other stakeholders deemed necessary as determined by the proposed outcomes of the engagement. These will be supplemented with quarterly engagements with local leadership.

Quarterly Engagement with Local Leadership

Throughout the construction phase, the Proponent will meet with the local leadership quarterly. The local leadership will serve as the main vehicle of communication between the Project and host communities. The local leadership will, at a minimum, discuss the following issues:

- Employment opportunities for local communities, and monitoring of achievement of quotas.
- Subcontracts / procurement opportunities for contractors from communities, and monitoring of local content achievement.
- Community development projects.
- Provision of scholarships and vocational training.
- Micro Grant for women

Engagement with the local leadership will be appropriately documented through capturing of minutes, action items, as well as updating the Project's commitment register.

Monthly Engagement with Youth

As a designated vulnerable group, the Project will engage with youth monthly to discuss opportunities for empowerment and socio-economic development throughout the construction phase.

Monitoring of Grievances

At the commencement of construction, the Project will actively monitor grievances raised against the Project or sub-contractor staff, as per the process outlined in Section Error: Reference source not found (Grievance Management Procedure). Where recurring grievances are identified, the Project will actively engage with stakeholders and aggrieved parties to address the cause of such recurring grievances.

7.1.4 OPERATIONAL PHASE

Annual Engagement with Local Leadership

The Project will continue to engage with local leadership as prescribed in any agreements reached with host communities.

Provide Broader Project Updates as Required

The MM FZE Facility will continue to provide broader feedback and updates to stakeholders beyond the local leaders regarding the operation of the Project, as well as any other pertinent information to be disclosed such as environmental exceedances and corrective measures to be implemented. Such engagements will take place on an *ad hoc* basis as the need arises, and the necessary stakeholders will be determined given the engagement objectives.

Monitoring of Grievances

The Proponent will actively monitor grievances raised against the MM FZE Facility or sub-contractor staff throughout the operational life of the Project, as per the process outlined in Section Error: Reference source not found of this SEP. Where recurring grievances are identified, the MM FZE Facility will actively engage with stakeholders and aggrieved parties to address the cause of such recurring grievances.

7.1.5 DECOMMISSIONING PHASE

This Section has been written on the assumption that decommissioning will only apply to the MM FZE Facility. Should decommissioning of Onne Port Complex occur, additional planning beyond the scope of this SEP will need to take place. Furthermore, the below should be considered as guidelines which will be further refined based on contextual factors at the time of decommissioning.

Announcement of Intended Decommissioning

Stakeholders will be informed of the intended decommissioning as soon as reasonably and practically possible, but no less than three months prior to the commencement of decommissioning activities. The Project will communicate the intended decommissioning via the local leaders, traditional leaders, community leaders, union representatives and youth leaders.

Quarterly Engagement with Local Leadership

During the decommissioning process the Project will meet with the local leadership quarterly to discuss the potential impacts of the decommissioning on host communities, as well as how these may be mitigated. Furthermore, the Proponent will discuss plans with the local leadership for the timely completion of commitments, as stipulated in the relevant MOUs as signed with the host communities, prior to the completion of decommissioning.

Provide Broader Decommissioning Updates as Required

The MM FZE Facility will continue to provide broader feedback and updates to stakeholders beyond the local leadership regarding the decommissioning of the Project, as well as any other pertinent information such as anticipated impacts on host communities. Such engagements will take place on an *ad hoc* basis as the need arises, and the necessary stakeholders will be determined given the engagement objectives. Sensitivity will be demonstrated for the potential consequences of decommissioning on livelihoods and socio-economic opportunities for host communities.

Monitoring of Grievances

At the commencement of decommissioning, the Project will actively monitor grievances raised against the MM FZE Facility or sub-contractor staff, as per the process outlined in Section Error: Reference source not found (Grievance Mechanism). Where recurring grievances are identified, the Project will actively engage with stakeholders and aggrieved parties to address the cause of such recurring grievances.

8. REPORTING, MONITORING, AND EVALUATION

In order to assess the effectiveness of this SEP and associated engagement activities, the Project will implement a data management and monitoring process as part of the overall monitoring of commitments, grievances, and performance.

8.1 REPORTING

The reporting and monitoring process will include stakeholder participation and ensure that areas of improvement and stakeholder feedback are addressed.

All engagement activities throughout the life of the Project will be documented and appropriately stored in order to track and refer to records when required and ensure delivery of commitments made to stakeholders. The following stakeholder engagement records and documentation will be used:

- **Minutes of the Meeting (MOM) / Resolutions during Stakeholder Engagement**: The proceedings of stakeholder engagements shall be recorded in MOM / Resolutions. In addition, the grievances raised during stakeholder engagement shall logged in the grievance register. The Community Relations Officer will monitor a log of actions and progress toward implementing these commitments regularly.
- The copies of MOM and resolutions will be made available to representatives of stakeholders present in the engagement process in response to addressing issues or grievances or made as part of management or mitigation measures.
- **Meeting Template**: Used to collect full meeting minutes to be captured within the stakeholder database**.**
- **Stakeholder Database**: A database of all Project stakeholders will be maintained throughout the life of the Project. The database should include contact information (name, contact number, email address, and affiliated stakeholder group). The database should also act as the repository for all stakeholder engagement logs and meeting minutes and should be maintained in such a way for ease of reference and auditing purposes.
- **Grievance Log**: To record all grievances received and progress in resolving them, to identify patterns, avoid recurrent problems and improve the MM FZE Facility's overall social performance. Grievances are to be addressed as per the requirements included in the Grievance Management Procedure.

8.2 MONITORING

The SEP will be monitored and evaluated regularly using the indicators as recommended by international best practice (e.g., IFC Stakeholder Engagement: A Good Practice Handbook for Companies Doing Business in Emerging Markets (2007)). The monitoring results, both qualitative and quantitative, will be disclosed as required by regulatory authorities and lenders Suggested monitoring and evaluation activities are outlined below:

- Monitor the grievance register in terms of response times to address complaints logged as well as the recurrence of complaints over time.
- Review and maintain an updated stakeholder list.
- Keep records of all engagement activities.
- Keep a library (electronic or hard copy) of all communication material.

- Develop and assess performance in terms of Key Performance Indicators (KPIs), such as:
- Number of engagement activities facilitated by stakeholder group and engagement type;
  - Number of attendees at stakeholder engagement activities (expected vs actual);
  - Number of grievances received per annum; and
  - Overall perceptions of the Project and company.
- MM FZE Facility (and in particular the head of HR and Industrial Relations) should ensure that the SEP be updated annually based on outcomes of monitoring exercise.
- A revision of the SEP should be conducted every 5 years, if there are any significant changes in stakeholder engagement dynamics.

9. GRIEVANCE MANAGEMENT PROCEDURE (GMP)

9.1 INTRODUCTION

The management of grievances is a vital component of stakeholder management and an important aspect of risk management for the Project. Grievances can be an indication of growing stakeholder concerns (real and or perceived).

MM FZE has a Grievance Management Procedure (GMP) which has undergone significant improvements during Train 1 and Train 2 projects. The same GMP shall be extended to ESIA, construction, and operations phases.

The GMP will actively track and manage external grievances, and the commitments associated with the grievance, to ensure that appropriate actions are taken, and resolutions achieved.

9.2 PURPOSE

The purpose of this GMP is to outline the Project's approach to accepting, assessing, resolving, and monitoring grievances from those affected by the Project, its Contractors' and activities in relation to the MM FZE Facility. The aim is to identify and manage grievances from individual stakeholders or stakeholder groups. Timely redress or resolution of such grievances is vital to ensure effective stakeholder management.

Grievances can encompass minor concerns, as well as serious or long-term issues. They may be felt and expressed by a variety of parties including individuals, groups, communities, entities, or other parties affected or likely to be affected by the social or environmental impacts of the Project. It is essential to have a robust and credible mechanism to systematically handle and resolve any complaints that might arise to avoid escalation and the realisation of a risk to operations or the reputation of MM FZE Project (nationally or internationally). If well-handled, an effective grievance management procedure can help foster positive relationships and build trust with stakeholders.

The mechanism for addressing employee grievances is not addressed through this SEP, which is intended to solely manage the interface with external stakeholders. For management of employee grievances, refer to the *MM FZE Facility Employee Grievance Management Procedure.*

9.3 SCOPE

This GMP will be applied to stakeholder complaints and grievances, perceived or actual, which relate to the activities of the MM FZE Facility, and its Contractors' undertaken in relation to all phases of the Project.

A complaint or grievance is an issue, concern, problem, or claim (perceived or actual) that an individual stakeholder or community group has related to MM FZE and its contractors' operations and activities. The mechanism does not impede access to judicial or administrative resolutions.

9.4 APPLICATION

The objective of this mechanism is to:

- Provide a predictable, transparent, and credible process to all parties for resolving grievances, resulting in outcomes that are seen as fair, effective, and lasting;
- Build trust as an integral component of broader community relations activities; and

- Enable more systematic identification of emerging issues and trends, facilitating corrective action and pre-emptive engagement.

To maximise the effectiveness of the GMP, the Project shall uphold the following values during implementation and operation of the system:

- Commitment to fairness in both process and outcomes;
- Freedom from reprisal for all involved parties – within the MM FZE Facility and in the external stakeholder group;
- Clear operating rules, and accountability;
- Validity of all complaints submitted;
- Culturally accessible and applicable;
- Accessible to vulnerable groups of stakeholders; and
- Confidentiality if requested.

9.5 ROLES AND RESPONSIBILITIES

Implementation of the GMP for the Project will be the ultimate responsibility of the Head - Community Relations and Development who will be supported by a wider team. The various roles of the Grievance Management Team are detailed below.

9.5.1 HEAD - COMMUNITY RELATIONS AND DEVELOPMENT

The Head - Community Relations and Development will:

- Implement the GMP procedure and management system providing guidance on solutions to complaints and grievances in consultation with the relevant departments and ensure consistency of redress for all grievances received in relation to the Project.
- Promote the GMP to maintain momentum and ensure company wide and community commitment to, and understanding of, its implementation and operation.
- Involvement in the investigation of grievances and the agreement of redress as well as overseeing interaction between various Departments and contractors as well as the senior managers as required.

9.5.2 ALL MM FZE FACILITY DEPARTMENTS AND CONTRACTORS

MM FZE Facility Departments and Contractors will:

- Receive and acknowledge any issue, concern, complaint, or grievance from the community, verbally or in writing. They will record the issue and report it to the Grievance Manager in compliance with the GMP.
- Involvement in the investigation of grievances as required depending on the nature and severity of the grievance and as directed by the Grievance Management team.

9.5.3 HEAD HUMAN RESOURCES AND INDUSTRIAL RELATIONS

Buy-in from senior leadership is vital to the success of a GMP, therefore, the Head of Human Resources and Industrial Relations, working through appropriate channels within the MM FZE Facility will:

- Ensure that this GMP procedure is applied through all Project and Contractor departments and levels that are undertaking activities related to the Project;
- Apply necessary controls to minimise risks that could result in stakeholder grievances; and
- Contribute to the resolution and closure of any grievances which have international repercussions.

The following resources will also need to be in place:

- An auditable system for receipt, recording and tracking of the process (for example a grievance log, database etc.) shall be in place.
- Dedicated budget for resourcing management of Grievance Mechanism and addressing grievances through financial or in-kind compensation as and when needed.

GRIEVANCE REDRESS PROCESS

The Project's GMP presents a simple process through which stakeholders can submit their complaints free of charge and, if necessary, anonymously or via third parties. Complaints may be submitted in more than one format. The preferable channels for reporting grievances will be confirmed with communities and will be discussed with the community as part of community engagement, primarily using the local leadership as a communication vehicle.

The Project's Grievance Redress Process is administered in six steps, as follows:

- Step 1: Receive and log grievance;
- Step 2: Acknowledge grievance;
- Step 3: Assess and Investigate;
- Step 4: Grievance Resolution;
- Step 5: Sign-off on grievance; and
- Step 6: Monitor.

Step 1: Receive and Log Grievance

Grievances can be submitted in writing, telephonically or presented verbally to the Grievance Officer using the following details:

- **In Person**: At the Community Relations and Development office of MM FZE Facility where the grievance officer will be at hand to take down the grievances in the grievance logbook.
- **Local leadership Representatives, and Local Government**. The MM FZE Facility Grievance Officer will collect grievances informally through these stakeholders.
- **Electronic**: E-mail address: Kendrick.oluka@indorama.com
- **Traditional means**: Phone number: 2348055064248
- **Letters**: Meliora Methanol FZE, Federal Ocean Terminal, Onne Port Complex, Oil & Gas Free Zone Onne, Eleme LGA, Port Harcourt, Rivers State, Nigeria.
- **The Grievance logbook / register -** is placed in every host community. The grievance register is entrusted to local leadership member from respective communities who are members Grievance Sub Committee. Grievance subcommittee members interact on regular basis as per the situation. The grievance subcommittee reviews the grievances on monthly basis. Further, grievances are quarterly reviewed in local leadership meeting.
- **Face-to-face**: At Quarterly local leadership meetings at the Indorama complex, Town halls and other community meetings (determined by the stakeholder engagement plan)
- The MM FZE Facility ensures that any personnel and contractors that could potentially receive claims will be knowledgeable about the grievance management process and ready to accept feedback. The MM FZE Facility will stress that there will be no costs or retribution associated with lodging grievances.

To facilitate tracking, evaluation and response to grievances, standardized information should be collected and recorded on the Grievance Recording logbook (Appendix A). The grievance is received by the Project or a Contractor representative and is forwarded to the Grievance Manager.

All grievances shall be logged using the Stakeholder Grievance Form (Error: Reference source not found). The MM FZE Facility will log, document and track all grievances received within the grievance database (refer to Error: Reference source not found for an example of a grievance database). Grievances shall be assigned a case number and records of communication/consultation shall all be securely stored within the Grievance database. The database shall be monitored regularly for recurring grievances so that appropriate mitigation can be developed. As a minimum, the following information shall be recorded:

- Log number;
- Complainant's name and contact details;
- Date of complaint;
- Details of complaint;
- History of other complaints / queries / questions (if known);
- Resolutions discussed and agreed with the party(ies) in question;
- Actions implemented (including dates); and
- Outcome of the actions implemented.

Step 2: Acknowledging Receipt of a Grievance

The MM FZE Facility shall acknowledge receipt of any grievance within seven days from the date it was submitted and shall inform the complainant about the timeframe in which a response can be expected. If the grievance is not well understood or if additional information is required, clarification will be sought from the complainant.

Step 3: Assess and Investigate Grievance

The following steps shall be undertaken to investigate all grievances:

1. Capture as much information as possible from the person who received the complaint, as well as from the complainant.
2. Undertake a site visit, if required, to clarify the parties and issues involved. Gather the views of other stakeholders including the MM FZE Facility employees, if necessary, and identify initial options for settlement that parties have considered.
3. Determine whether the grievance is eligible.
    - Eligible grievances include all those that are directly or indirectly related to the MM FZE Facility Project and that fall within the scope of the GMP as outlined above.
    - Ineligible complaints may include those that are clearly not related to the MM FZE Facility Project or its contractors' activities, whose issues fall outside the scope of the GMP or where other Project or community procedures would be more appropriate to address the grievance.
4. If the grievance is deemed ineligible it can be rejected, however, a full explanation as to the reasons for this must be given to the complainant and recorded in the Grievance Database.
5. If the grievance is eligible, determine its severity level using the significance criteria in Box 9.1. This will determine whether the grievance can be resolved immediately or requires further investigation and whether senior management will need to be informed of the grievance.
6. If the grievance concerns physical damage, (e.g., crop, house, community asset) take a photograph of the damage and record the exact location as accurately as possible.
7. Inform the complainant of the expected timeframe for resolution of the grievance.
8. Enter the findings of the investigation in the Grievance Database.

The Project will aim to resolve any grievances within 30 days from date of receipt. This timeframe can be extended to 60 days for more complex grievances e.g., level 4 grievances (refer to Box 9.1 for the significance rating criteria of grievances), if required, and following communication and engagement with the complainant.

BOX 9.1 SIGNIFICANCE RATING CRITERIA

Significance Level	Type of Grievance	Responsibility
Level 1	A grievance that is isolated or 'one-off' and essentially local in nature and restricted to one complainant. Note: Some one-off grievances may be significant enough to be assessed as a Level 4 grievance e.g., when a national or international law is broken (see Level 4 below)	Grievance Manager
Level 2	A grievance that extends to the local community or region and has occurred more than once, which is judged to have the potential to cause disruption to Indorama operations or to generate negative comment from local media or other local stakeholders	Project Executive
Level 3	A grievance which is widespread and repeated or has resulted in long term damage and/or has led to negative comment from local media, or is judged to have the potential to generate negative media and local stakeholder comments (e.g., damage to a sacred site or flooding of local school)	Project Executive
Level 4	A one-off complaint, or one which is widespread or repeated and, **in addition,** has resulted in a serious breach of Indorama policies, Nigerian or International Law and/or has led to negative national/international media attention, or is judged to have the potential to generate negative comment from the media or other key stakeholders (e.g., failure to pay compensation where appropriate, e.g., resettlement)	Indorama Chief Executive

Step 4: Grievance Resolution

All grievances will be dealt with on a case-by-case basis. The approach adopted will seek to facilitate dialogue with complainants and community members to jointly identify and select measures for grievance settlement. This will help to increase ownership of solutions and to mitigate perceptions that resolutions unfairly benefit Indorama.

An incident investigation team from the Project may be tasked with seeking resolution to the grievance. This may entail a dialogue or series of dialogues between affected parties to find a solution to the grievance. Alternatively, it may entail investigating the underlying cause of the grievance and action any changes required to internal systems to prevent a recurrence of a similar grievance.

An Incident Investigation Report will be completed within 28 days (considered good practice). During the 28 days of dialogue or investigation, the Grievance Manager will co-ordinate conflict resolution activities necessary to contain and resolve any actual or potential conflicts arising from the reported grievance. If the case is complex and the stated resolution timeframe cannot be met, an interim response will be provided (oral or written) that informs the stakeholder of the delay, explains the reasons, and offers a revised date for next steps.

Where possible, grievances will be addressed directly by the MM FZE Facility. The resolution proposal shall be respectful and considered, including a substantiating rationale for the decision and any data used in reaching it. If wider consultation is necessary, grievances will be forwarded to a third party. This third party should be neutral, well-respected, and agreed upon by both the Project and the affected parties. These may include public defenders, legal advisors, local or international NGOs, or technical experts. In cases where further arbitration is necessary, appropriate government involvement will be requested.

As a last resort, aggrieved parties have a right to take legal action. This more formal rights-based approach shall only be taken if all other approaches have failed or when there are serious conflicts about facts and data. The final decision will be taken by the arbitrator or courts based on compliance with laws, policies, standards, rules, regulations, procedures, past agreements or common practice.

Step 5: Closure of Grievance

The Head - Community Relations and Development will communicate to the complainant(s) that the grievance has been resolved. In instances where the stakeholder is not satisfied with actions taken, the grievance will either:

- Be escalated to senior management and a decision will be taken either to implement supplementary actions or to consider initiating an appeal process;

  OR

- The Grievance Manager will approach a neutral or third party to assist in mediating and resolving the grievance;

  OR

- The Grievance Manager will approach the host country's judiciary to further address the grievance.

Following this process, the Grievance Manager will communicate that actions implemented have resolved the grievance.

The staff member who signs off on the closure of the grievance should have sufficient knowledge about the topic to provide assurance.

Once sign-off has occurred, this should be recorded in the Grievance Log.

Step 6: Monitoring and Reporting

The MM FZE Facility management will monitor grievances routinely as part of the broader management of the Project. This entails good record keeping of complaints raised throughout the life of the construction and operation of the Project. On receipt of grievances, electronic notification to management must be distributed. Grievance records must be made available to management at all times.

Quarterly internal reports will be compiled by the Grievance Manager and distributed to the management team. These grievance reports will include:

- The number of grievances logged in the proceeding period by level and type.
- The number of stakeholders that have indicated after 30 days that they are not satisfied with the resolution.
- The number of grievances unresolved after 60 days by level and type.
- The number of grievances resolved between Indorama and complainants, without accessing legal or third-party mediators, by level and type.

- The number of grievances of the same or similar issue.
- The measures taken to incorporate these grievance outcomes into Project design and implementation.

These reports and other records will be made available for external review if required. An appropriate grievance report should form part of Indorama's annual reporting.

APPENDIX A GRIEVANCE RECORDING LOGBOOK FORMAT

S/N (Case number)	Complaint Registered Date Compliant	Complaint received from (Name of Person and contact details)	Name of community	Complaint Description	History of other complaints / queries / questions (if known)	Investigation/ management action	Closed out	Remark

APPENDIX B COMMUNITY GRIEVANCE MANAGEMENT ANALYSIS AND TRACKING

S/N	Community	Log Date	Log Description	Grievance Category	Grievance Officer's Remarks	Responsibility	Resolutions discussed and agreed with the party(ies) in question	Actions implemented (including dates);	Closed out / Outcome of the actions implemented	Management Action	Review Date	Review Year	Status	Avg Duration (months)