Final Environmental Impact Assessment (EIA) Report to Support the Application for Environmental Clearance Certificate (ECC) for the Proposed 2D Seismic Survey covering the Area of Interest (AOI) in the Petroleum Exploration License (PEL) No. 73, Kavango Sedimentary Basin, KAVANGO WEST AND EAST REGIONS, NORTHERN NAMIBIA

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March 2021
OPERATOR
Reconnaissance Energy Namibia (Pty) Ltd Subsidiary of Reconnaissance Energy Africa Ltd (ReconAfrica)

ECC REFERENCE APPLICATION No.
APP-002250

LICENSE PEL 73
Degree Square Blocks 1719, 1720, 1721, 1819, 1820 and 1821

WORKING INTERESTS
ReconAfrica owns 90%
National Petroleum Corporation of Namibia (Namcor) (A State-Owned Company) 10% with costs carried to the development stage

TYPE OF PETROLEUM EXPLORATION ACTIVITIES
2D Seismic Survey Operations

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## ENVIRONMENTAL IMPACT ASSESSMENT (EIA) REPORT

### CONSULTING TEAM

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<th>Name</th>
<th>Project Role / Position / Specialisation</th>
<th>Affiliation / Company</th>
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<tr>
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</tbody>
</table>
I, Dr Sindila Mwiya, the EAP for this Environmental Assessment process conducted to support the application for Environmental Clearance Certificate (ECC) for the proposed 2D seismic survey operations over the Areas of Interest in the Petroleum Exploration License (PEL) No. 73, Kavango Sedimentary Basin, Kavango West and East Regions for Reconnaissance Energy Namibia (Pty) Ltd (Proponent), hereby declares that:


2. As an EAP for this ECC application, I am highly qualified and experienced and hold a PhD with research interests, academic training and knowledge in Engineering Geology / Geotechnical / Geoenvironmental / Environmental Engineering, Artificial Intelligence and Knowledge-Based Systems with special focus on EIAs, EMPs, EMSs, SEAs and SEMPs with respect to subsurface resources (minerals, petroleum, water) and energy in Arid and Semiarid Environments (Engineering and Environmental Geologist).

3. I have knowledge and experience in conducting environmental assessments, management, and monitoring, and have undertaken more than 200 projects since 2004, including more than 55 oil and gas exploration and production related environmental assessments, management, and monitoring projects in different parts of the World.

4. I have performed the work relating to this ECC application in an objective manner, even if the outcomes will result in views or Records of Decision that may not be favourable to the Interested and Affected Parties (I&APs) or the Proponent.

5. I am an independent consultant not related to the Proponent, I co-own and operate an independent company (Risk-Based Solutions CC) which not related to the Proponent and I have no shares, interests, or involvement in the license, financial or other affairs or business or operational decisions of either the Proponent or the decision-making structures of the relevant Government institutions.

Dr Sindila MWIYA
Environmental Assessment Practitioner (EAP)
RISK-BASED SOLUTIONS (RBS) CC
STATEMENT OF QUALIFICATIONS OF THE ENVIRONMENTAL ASSESSMENT PRACTITIONER

Dr Sindila Mwiya is more than eighteen (18) years of practical field-based technical industry experience in Environmental Assessment (SEA, EIA, EMP, EMS), Energy (Renewable and Non-renewable energy sources), onshore and offshore resources (minerals, oil, gas and water) exploration / prospecting, operation and utilisation, covering general and specialist technical exploration and recovery support, Health, Safety and Environment (HSE) permitting for Geophysical Surveys such as 2D, 3D and 4D Seismic, Gravity and Electromagnetic Surveys for mining, energy and petroleum (oil and gas) operations support, through to engineering planning, layout, designing, logistical support, recovery, production / operations, compliance monitoring, rehabilitation, closure and aftercare projects lifecycles. He continues to work internationally in the resources (mining and petroleum) and energy sectors, from permitting through to exploration and production. From the frontier regions (high risk hydrocarbons exploration zones) of South Africa and Namibia, to the prolific oil and gas fields of the Middle East, Angola and the West African Gulf of Guinea. Dr Mwiya has been directly involved in field-based aerial, ground and marine geophysical (gravity, magnetics and seismic) surveys, been onboard exploration drilling rigs, onboard production platforms, conducted public and stakeholder consultations and engagements, and worked with highly technical and well organised and committed clients and third-party teams from emerging and well established global resources and energy companies from many countries such as the UK, France, USA, Russia, Canada, China, South Africa, Equatorial Guinea, Angola and Nigeria. He is fully aware of all the competing interests and niche donation-based business environmental advocacy opportunism that exists in the resources sector from the local, regional, and international perspectives.

Through his companies, Risk-Based Solutions (RBS) CC and Foresight Group Namibia (FGN) (Pty) Ltd which he founded, he has undertaken and managed more than two hundred (200) mining projects for Local (Namibian), Continental (African and International) based clients. He has worked and continue to work for Global, Continental and Namibian based reputable resources (petroleum and mining / minerals) and energy companies such as Dundee Precious Metals (Namibia / Canada), Headspring Investment (Namibia / Russia), EMGS (UK / Norway), Lepidico (Australia / UK), Best Sheer / Bohale (Namibia / China), CGG Services UK Limited (UK/ France/Namibia), BW Offshore (Norway/Singapore /Namibia), Shell Namibia B. V. Limited (Namibia/ the Netherlands), Tullow Oil (UK/Namibia), Debmearne (DBMN) (Namibia), Reconnaissance Energy Africa Ltd (ReconAfrica) (UK/Canada/Namibia), Osino Resource Corporation (Canada/USA/Namibia), Petrosbras Oil and Gas (Brazil / BP /UK)/ Namibia, REPSOL (Spain/ Namibia), ACREP (Namibia/Angola), Martinez Exploration (UK/ South Africa), HRT Africa (Brazil / USA/ Namibia), Charriot Oil and Gas (UK / UAE/ Namibia), NABIRM (USA/ Namibia), Serica Energy (UK/ Namibia), Eco (Atlantic) Oil and Gas (Canada / USA/ Namibia), ION GeoVentures (USA), PGK Exploration (UK), TGS-Nopec (UK), Maurel & Prom (France/ Namibia), GeoPartners (UK), PetroSA Equatorial Guinea (South Africa / Equatorial Guinea / Namibia), Preview Energy Resources (Namibia / UK), Sintezneftegaz Namibia Ltd (Russia / Namibia), INA Namibia (INA INDUSTRIJA NAFTFE d.o.) (Croatia/ Namibia), Namibia Underwater Technologies (NUTAM) (South Africa/Namibia), InnoSun Holdings (Pty) Ltd and all its subsidiary renewable energy companies and projects in Namibia (Namibia / France), HopSol (Namibia/Switzerland), Momentous Solar One (Pty) Ltd (Namibia / Canada), OLC Northern Sun Energy (Pty) Ltd (Namibia) and more than 100 local companies. Dr Sindila Mwiya is highly qualified with extensive practical field-based experience in petroleum, mining, renewable energy (Solar, Wind, Biomass, Geothermal and Hydropower), Non-Renewable energy (Coal, Petroleum, and Natural Gas), applied environmental assessment, management, and monitoring (Scoping, EIA, EMP, EMP, EMS) and overall industry specific HSE, cleaner production programmes, Geoenvironmental, geological and geotechnical engineering specialist fields.

Dr Sindila Mwiya has undertaken and continue to undertake and manage high value projects on behalf of global and local resources and energy companies. Currently, (2020-2023) Dr Sindila Mwiya is responsible for permitting planning through to operational and completion monitoring, HSE and engineering technical support for multiple major upstream onshore and offshore petroleum, minerals, 200 mining projects, Solar and Wind Energy Projects, manufacturing and environmentally sustainable, automated / smart and Climate Change resilient homes developments in different parts of the World including Namibia. He continue to worked as an International Resources Consultant, national Environmental Assessment Practitioner (EAP) / Environmentally Sustainable, automated / smart and Climate Change resilient homes developer, Engineering / Technical Consultant (RBS / FGN), Project Manager, Programme Advisor for the Department of Natural and Applied Sciences, Namibia University of Science and Technology (NUST) and has worked as a Lecturer, University of Namibia (UNAM), External Examiner/ Moderator, NUST, National (Namibia) Technical Advisor (Directorate of Environmental Affairs, Ministry of Environment, Forestry and Tourism / DANA) Cleaner Production) and Chair of Environmental Division for Engineering and Environment (EE) Namibia, Site Managers of Mines and Energy and a Field-Based Geotechnician (Specialised in Magnetics, Seismic, Gravity and Electromagnetics Exploration and Survey Methods) under the Federal Institute for Geoscience and Natural Resources (BGR) German Mineral Exploration Promotion Project to Namibia, Geophysics Division, Geological Survey of Namibia, Ministry of Mines and Energy.

He has supervised and continue to support a number of MScs and PhDs research programmes and has been a reviewer on international, national and regional researches, plans, programmes and projects with the objective to ensure substantial local skills development, pivotal to the national socioeconomic development through the promotion of sustainable natural resources coexistence, management, development, recovery, utilisation and for development policies, plans, programmes and projects financed by governments, private investors and Namibian development partners. Since 2006 until 2017, he has provided extensive technical support to the Department of Environmental Affairs (DEA), Ministry of Environment, Forestry and Tourism (MEFT) through GIZ in the preparation and amendments of the Namibian Environmental Management Act, 2007, (Act No. 7 of 2007), Strategic Environmental Assessment (SEA) Regulations, Environmental Impact Assessment (EIA) Regulations as well as the SEA and EIA Guidelines and Procedures all aimed at promoting effective environmental assessment and management practices in Namibia.

Among his academic achievements, Dr Sindila Mwiya is a holder of a PhD within the broader fields of Engineering Geology/Geotechnical / Geoenvironmental / Environmental Engineering and Artificial Intelligence with a research thesis titled Development of a Knowledge-Based System Methodology (KBSM) for the Design of Solid Waste Disposal Sites in Arid and Semiarid Environments, MPhil/PG Cert and BEng (Hons) (Engineering Geology and Geotechnics) qualifications from the University of Portsmouth, School of Earth and Environmental Sciences, United Kingdom. During the 2004 Namibia National Science Awards, organised by the Namibian Ministry of Education, and held in Windhoek, Dr Sindila Mwiya was awarded the Geologist of the Year for 2004, in the professional category. Furthermore, as part of his professional career recognition, Dr Sindila Mwiya is a life member of the Geological Society of Namibia, Consulting member of the Hydrogeological Society of Namibia and a Professional Engineer registered with the Engineering Council of Namibia.

Namibia, Windhoek, March 2021
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Non-Technical Summary

Reconnaissance Energy Namibia (Pty) Ltd, (the "Proponent"), is a subsidiary of Reconnaissance Energy Africa Ltd (ReconAfrica), a Canadian publicly listed company. The Proponent holds petroleum exploration rights under the Petroleum Exploration License (PEL) No. 73 covering Degree Square Blocks 1719, 1720, 1721, 1819, 1820 and 1821 over the newly discovered Kavango Sedimentary Basin, Kavango West and East regions in northern Namibia.

PEL 73 is granted under Section 29-38 of the Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991) administered by the Ministry of Mines and Energy (MME) as the Competent Authority in petroleum exploration and production operations in Namibia. ReconAfrica is the Operator of PEL 73 holding 90% of the license interests and the remaining 10% is held by the National Petroleum Corporation of Namibia (Namcor) with its costs carried to the development stage. As part of the provisions of the Petroleum Agreement signed between ReconAfrica and the Government of the Republic of Namibia represented by the Ministry of Mines and Energy (MME), the Proponent has committed to undertaking petroleum exploration activities in PEL 73. The Petroleum Agreement provides for the initial exploration period (4 years), first and second two (2) years renewal exploration periods subject to possible one-year extension. In an event of a discovery of economic oil and gas reserves, the Proponent may apply for a 25-year production license, which should be granted within six (6) months of the date of application.

Petroleum exploration involves the implementation of multiple but interlinked exploration steps over many years and each major step requires a separate environmental assessment processes to be conducted as provided for under the Environmental Protection Clause 11 of the Petroleum Agreement signed between the Proponent and the Government of the Republic of Namibia, Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991), Petroleum Laws Amendment Act, 1998, (Act 24 of 1998), the Environmental Management Act, 2007, (Act No. 7 of 2007) and all other applicable national laws and Regulations subject to the type of exploration activities being undertaken at any given time.

To date ReconAfrica has delineated the Kavango Sedimentary Basin subsurface feature as a key exploration Area of Interest (AOI) based on the interpretation of the available Government high resolution aerial geophysical data, regional structural geological mapping, and historical well data from the Etosha Basin. In order to confirm the presence of an active petroleum system and validate the existence of the Kavango Sedimentary Basin, stratigraphic wells will be drilled to study the geology of the AOI and the first of such wells is currently being drilled near Kawe Village in Kavango East Region. Following on the drilling of the stratigraphic wells, the Proponent intends to conduct 450 km long of 2D seismic survey operations over the AOI in order to search for geological structures called reservoirs which could have the potential for holding economic hydrocarbon resources. Depending on the outcomes of the proposed 2D seismic survey operations, exploratory drilling operations over the 2D seismic survey delineated hydrocarbon structural reservoirs may be undertaken over the AOI followed by more appraisal exploration drilling if there is a commercial discovery.

In fulfilment of the environmental requirements for the proposed 2D seismic survey, the Proponent has appointed Risk-Based Solutions (RBS) CC as the Environmental Consultant and led by Dr Sindila Mwiya as the Environmental Assessment Practitioner (EAP) to conduct an Environmental Assessment comprising the preparation of the Scoping, Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) reports to support the application for Environmental Clearance Certificate (ECC) for the proposed 2D seismic survey operations.

The Environmental Assessment process, has taken into considerations all the applicable national regulations, the corporate requirements of the Proponent, oil and gas exploration and environmental assessment international best practices, the inputs of the public and stakeholders and sensitivity of the receiving environment (physical, biological, socioeconomic and ecosystem services and functions). The following is the summary of the key sources of positive and negative impacts likely to be associated with the proposed 2D seismic survey operations:

(i) Planning and mobilisation (Pre-survey preparation).
(ii) Camp sites setups and widening of tracks and creation of limited new access as may be applicable.

(iii) Actual data acquisition along the individual profiles / survey lines.

(iv) Demobilisation and Closure (Survey Completion), and.

(v) Any accidental event that may be associated with the routine and physical presence operational activities.

The proposed survey operations covering the key exploration Areas of Interest (AOI) within PEL 73 will be conducted along existing roads and tracks, using a limited footprint and efficient light trucks called the Explorer 860 Accelerated Weight Drop (AWD) as the energy sources and will utilise wireless receivers that will allow for greater line offsets. The weight-drop, which will generate a thump as it hits the ground at a frequency of 300Hz, is not expected to have any frequency specific interference with the local fauna such as the elephants known to have communication frequency ranges of between 14-35Hz, far below survey frequency. 2D seismic survey waves are different from earthquake created seismic waves. Earthquake generate seismic waves have periods and resolution of minutes and kilometres, respectively, while the 2D seismic survey operations produces waves with periods and resolution of tenths of a second and tens of meters respectively.

During the seismic survey operations to be conducted only during the day times, the weigh drop will generate acoustic waves which will travel into the earth's crust and gets reflected by various subsurface formations, and will returns to the surface where it will be recorded by the receivers called geophones. The resultant product following complex processing is a vertical sonic cross-section of the subsurface beneath the survey line showing the geological materials (de-risked geological sub-model) and structures that the acoustic wave has travelled through. The interpreted 2D seismic survey data is used to find specific potential areas (potential reservoirs) within the AOI where oil or gas may be trapped in sufficient quantities. Further targeted site-specific exploration activities such as exploration and appraisal drilling operations may or may not be undertaken subject to the results of the 2D seismic survey.

The environmental assessment process used for this project took into considerations the provisions of the Environmental Impact Assessment (EIA) Regulations, 2012 and the Environmental Management Act (EMA), 2007, (Act No. 7 of 2007). The environmental assessment process started with the proposed project (2D seismic Survey) screening, followed by the preparation of the scoping report, public and stakeholder consultations and preparation of this EIA report and separate EMP report supported by a team of specialist consultants on fauna, flora, habitats, socioeconomic, water, archaeology, noise, vibrations, and dust.

The proposed 2D seismic survey area falls within the hot semi-arid climatic zone of northern Namibia, with hot summers and mild winters. Diurnal temperatures are more pronounced in winter, than in summer. Rainfall decreases generally from north to south, with an even gradient across the flat landscape. Rainfall falls mostly in summer with no rainfall of significance between May to August. Most rain occurs between December to March, with the highest rainfall peaking in January. The annual average rainfall for the Kavango region lies between 500-600mm.

The key Areas of Interest (AOI) (potential sedimentary basin areas) within PEL 73 falls within Kavango-Zambezi Transfrontier Conservation Area (KAZA TFCA). KAZA TFCA is a multiple land use international transboundary conservation initiative with a common vision of promoting and supporting sustainable livelihoods through coexistence and utilisation of multiple resource and resources areas for the greater benefits of the local communities of the member states (www.met.gov.na). KAZA TFCA is a transboundary initiative covering portions of Angola, Botswana, Namibia, Zambia, and Zimbabwe. The key multiple surface resource areas found within KAZA TFCA includes: National parks, game reserves, forest reserves, conservancies, game/wildlife management areas, communal lands, as well as subsurface resources such as water, minerals, geothermal energy, and petroleum that unfortunately are mentioned in the initiatives. Key targeted beneficiaries of the KAZA TFCA initiative are the local people especially the rural communities living around these resources and whose livelihoods are dependent on seasonal subsistence agriculture, animal husbandry, fishing, natural resource harvesting,
tourism, trading, and hunting. In Namibia and in other KAZA TFCA member states, the exploration and utilisation of potential subsurface resources found under KAZA TFCA are allowed, except in the formally proclaimed national park areas of Namibia.

The proposed 2D seismic survey area and the AOI is not situated in the active catchment areas of the Okavango River Basin but in fossil channels of the Omatako Omuramba Ephemeral river and its ephemeral tributaries. According to Oldeland et. al., (2013), the Omatako Ephemeral River has not contributed to runoff from the Okavango for over 50 years. Overall, the key central exploration interests within PEL 73 are situated about 55 km south of Rundu, 80 km south of the Okavango River, more than 260 km from the Okavango Delta in Botswana and not related to the active catchment area of the Okavango Delta whatsoever, more than 40 km from the boundary of the Khaudum National Park and more than 70 km from the Mangetti National Park. The overall general area falls in the sparsely populated but not pristine communal areas of the Ncamangoro and Mashare Constituencies of the Kavango West and East Regions, respectively. Ncamangoro and Mashare Constituencies falls within the boundaries of the Mbunza and Sambyu Traditional Authorities, respectively.

The local land uses in the general area is mainly communal / subsistence farming comprising cattle, donkeys, seasonal crop farming, grass, and wood / timber harvesting, conservancies and forestry conservation and natural resources harvesting, and very limited to no local tourism products. The following is the summary of some of the current common general threats to the natural environment and habitats of the general project area inclusive of the AOI and the area covered by the proposed 2D seismic survey operations:

(i) Accelerated allocation of communal leaseholds resulting in forestry clearing.

(ii) Subsistence communal crop farming centred on forestry clearing, slash and burn practices.

(iii) Wild fires linked to local human activities such clearing of the forestry for agricultures or creation of fresh grass for animal grazing.

(iv) Timber and wood harvesting, and.

(v) Overgrazing due to increased number of animals.

It is estimated that at least 67 species of reptile, 32 amphibian, 116 mammal and 210 bird species (breeding residents) are known to or expected to occur in the general Kavango and West East regions of the proposed project area. It is estimated that at least 107 species of larger trees and shrubs (>1m in height) and up to 111 species of grasses are known to or expected to occur in the general area, none of which are viewed as endemic species to the area.

The area of interest (Kavango Sedimentary Basin) within PEL 73 and proposed 2D seismic survey area falls within the greater Kalahari Basin which is the result of uplift of the Great Escarpment and deposition of Kalahari Group Sediments in grabens which formed during recent tectonics. Basement rocks below the top Kalahari Group of the Kavango Sedimentary Basin are expected to be Karoo Basalts, Damara Quartzites and Dolomites and Pre-Damara Basement. The Kalahari Basin is a vast inland basin stretching over Angola, Namibia, Zambia, Botswana, and South Africa.

A group of archaeological heritage sites within the general area but not necessary within the AOI are known to exist along the Omatako River basin between Ncaute and Taratara villages and southwest of Omatako River basin. These sites will not be impacted by the proposed 2D seismic survey operations neither are they vulnerable nor sensitive.

Groundwater within the Kavango Sedimentary Basin are primary aquifers of the Kalahari Group sediments and secondary aquifers as the result of faults, fractures, and weathering. The Kalahari sediments have variable yield and water quality and have groundwater potential which is moderate to low. Aquifers present along the rivers are saline artesian aquifers overlain by alluvium aquifers of paleo-channels of the Okavango River. The main sources of groundwater are hand dug wells and boreholes. Groundwater is located deeper to the west than in the east. Groundwater flow of the general area is controlled by faulting of the area, with a low-gentle gradient. Boreholes in general have low yields of
between 2-4m³/h, with average yields of 8m³/h. Groundwater occurring in the area is of good quality with Total Dissolved Solid (TDS) levels of 500-1000mg/l. Boreholes with poor quality water are stagnant waters, high in sodium salts. Recharge improves water quality with each recharge episode. Average borehole depth is slightly above 90m, with average water strikes at 51m and saturated thicknesses of 43m. Borehole yields are sufficient to fulfil the water requirements of the exploration phase of ReconAfrica.

As part of the environmental assessment, the following extensive public, stakeholders and regulatory consultations and field-based verifications were undertaken during the months January, February, and March 2021:

1. Ministry of Environment, Forestry and Tourism stakeholders consultation and field-based visits/verifications of the proposed 2D seismic survey area and drilling locations undertaken in Kavango East and West Regions on the 18th and 19th January 2021.

2. Formal public meeting (morning and afternoon sessions) held at Nkurenkuru Community Hall in Nkurenkuru Kavango West Region on the 20th January 2021.

3. Formal public meeting (morning and afternoon sessions) held at AMTA Rundu, Kavango East Region on the 22nd January 2021.

4. Sivaradi 1 and 2, Kavango West Region formal community meeting held under the community meeting tree on the 23rd January 2021.

5. Gcaru, Kavango West Region formal community meeting held under the community meeting tree on the 23rd January 2021.

6. Ncuncuni, Kavango West Region formal community meeting held under the community meeting tree on the 25th January 2021.

7. Ncaute, Kavango East/West Regions formal community meeting held under the community meeting tree on the 26th January 2021.

8. Makandina, Kavango East Region formal community meeting held under the community meeting tree on the 27th January 2021.

9. Windhoek, Khomas Region formal public meeting held Hotel Thule, Windhoek on the 2nd February 2021 organised by ReconAfrica and Namibia Chamber of Environment (NCE).

10. Mutwegombahe, Kavango East Region formal community meeting held under the community meeting tree on the 8th February 2021 (morning sessions).

11. Mbambi, Kavango East Region formal community meeting held under the community meeting tree on the 8th February 2021 (midday session).

12. Cuma, Kavango East Region formal community meeting held under the community meeting tree on the 8th February 2021 (Late afternoon session).

13. Omega 1 Community, covering Omega 1, Chetta, Mangarangandja, Mutjiku, Mushashani and Mshasho Villages in Bwabwata National Park, Western Zambezi Region (18th March 2021, morning Session), and.

14. Masambo Community, covering Masambo, Poca, Omega 3, Chetto, Muteik, Pipo and Ionxei villages in Bwabwata National Park, Western Zambezi Region, 18th March 2021, (Late Afternoon Sessions).

Appropriate meeting delivery methods and materials were adapted for each of the public/stakeholder and community meetings and took into considerations the national COVID-19 restrictions and requirements that were in place at the time of conducting the meetings. Details on the outcomes of the
meetings as well as written submissions received are attached to this EIA Report. Written submissions and inputs from the public meetings have been incorporated in the preparation of this EIA Report with mitigation measures covered in the separate EMP Report.

Overall, the proposed 2D seismic survey activities will have high positive impacts on the socioeconomic environment at national, regional, and local community levels. The overall severity of potential negative environmental impacts of the proposed 2D seismic survey activities on the receiving environment will be of low magnitude, temporally duration, localised extent, and low probability of occurrence due to the limited scope of the proposed activities to be conducted along existing roads and tracks. The survey will utilise wireless receivers which will make it easier to deploy larger, denser and achieve longer offsets for deeper targets. Newly developed processing algorithms will be used to find signal in the noise, thereby extending the application of useful frequencies both lower and higher bands.

Ground motion caused by an onshore seismic survey vibration is generally barely perceivable (Teasdale et al., 2006). The further away one is from the source, the less one would feel the vibration. Studies have shown that common household activities such as hammering a nail into a wall would cause more vibration to a house than a typical seismic truck operating in the area. Based on the results of several previous onshore 2D seismic surveys that have been conducted globally as well as in Namibia including those undertaken in recent years in the Nama Basin near Maltahöhe in southern Namibia 2007 and south of Nkurenkuru in Kavango West Region in 2017, onshore seismic survey can be used even in sensitive and urban locations without damaging buildings or affecting any receiving environmental components because the level of ground displacement due to the 2D seismic wave is insignificant compared to the familiar earthquake generated seismic wave which sometimes results in significant damage to the receiving environment.

Mitigation measures have been recommended and are contained in a separate EMP Report Vol. 3 of 3. Through the effective implementation of the mitigation measures and performance monitoring by the Proponent, the overall likely negative impacts of the proposed 2D ground seismic survey activities on the receiving environment (physical, socioeconomic, and biological) will be low and localised with low significant negative impacts.

Based on the findings of this EIA Report and the recommended mitigation measures detailed in the EMP Report, it is hereby recommended that the proposed 2D ground seismic survey over the key Areas of Interest (AOI) in PEL No. 73 shall be issued with an Environmental Clearance Certificate (ECC) with the following key conditions:

1) The Proponent must adhere to the provisions of all the national legislation, regulations, policies, procedures and permits / authorisation requirements.

2) The proponent shall adhere to all the provisions of the EMP and mitigation measures shall be implemented and monitored.

3) Before the implementation of the proposed 2D ground seismic survey operations, the Proponent shall consult with the local community / owners of the communal fields that may be used or likely to be disturbed by the proposed project activities. All the consultations shall be undertaken through the Office of the Governor for Kavango West and West, local Councillors and / Traditional Authorities, and.

4) Written consent shall always be obtained from the land owners and local community through the traditional authorities, and regional council as may be applicable to avoid misunderstanding and unnecessary conflicts.
1. PROJECT BACKGROUND

1.1 Introduction

Reconnaissance Energy Namibia (Pty) Ltd, herein referred as ReconAfrica holds petroleum exploration rights under the Petroleum Exploration License (PEL) No. 73 covering Degree Square Blocks 1719, 1720, 1721, 1819, 1820 and 1821 in Kavango Sedimentary Basin, Kavango West and East regions, northern Namibia (Figs. 1.1 and 1.2). PEL 73 has been granted under Section 29-38 of the Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991) administered by the Ministry of Mines and Energy (MME) as the Competent Authority. Reconnaissance Energy Namibia (Pty) Ltd, is a subsidiary of Reconnaissance Energy Africa Ltd (ReconAfrica), a Canadian public listed company. ReconAfrica is the Operator of PEL 73 holding 90% of the license interests. The National Petroleum Corporation of Namibia (Namcor), a Namibian State-owned company (Parastatal) holds the remaining 10% interest in the Licence, with its costs carried to the development stage.

PEL 73 was granted in January 2015 and exploration period continues to January 2024 with the rights to extend to January 2026. Following declaration of a commercial discovery, the Petroleum Agreement entitles ReconAfrica to apply for a production licence having a 25-year term. The fiscal terms of the Petroleum Agreement call for a 5% royalty, and an additional profits tax that applies late in the life of a producing field. ReconAfrica’s Namibian subsidiary, Reconnaissance Energy Namibia (Pty) Ltd, is required to pay Namibian corporate income tax of 35%.

1.2 ReconAfrica Work Commitment and Legal Obligations for PEL 73

1.2.1 Petroleum Agreement

The exploration activities that ReconAfrica has undertaken, is currently undertaking, and is planning to undertake form part of the work commitments and legal obligations as agreed between ReconAfrica and the Republic of Namibia detailed in the Petroleum Agreement concluded in line with the provisions of the Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991), Petroleum Laws Amendment Act, 1998, (Act 24 of 1998).

As part of the provisions of the Petroleum Agreement signed between ReconAfrica and the Government of the Republic of Namibia represented by the Ministry of Mines and Energy (MME), ReconAfrica has committed to undertaking petroleum exploration activities in PEL 73. As a global standard practice, petroleum exploration involves the implementation of multiple exploration steps over many years and each of the following summarised steps 2-5 requires separate environmental assessment processes to be conducted as provided for in Environmental Protection Clause 11 of the Petroleum Agreement, Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991), Petroleum Laws Amendment Act, 1998, (Act 24 of 1998), the Environmental Management Act, 2007, (Act No. 7 of 2007) and all other applicable national laws and Regulations of the Republic of Namibia:

1. **Step 1**: An applicant develops a theoretical hydrocarbon model and apply for a Petroleum Exploration License (PEL) and once the license is granted there is no requirement for undertaking environmental assessment and obtaining the Environmental Clearance Certificate (ECC) over the entire license area. The environmental assessment and all other applicable permits are only required once the PEL holder decides to implement exploration activities such as drilling or seismic survey that are listed in the applicable laws or may require other permits as may be applicable.

2. **Step 2**: Collection of the existing key historical data sets pertaining to petroleum geology, sedimentary basin, aerial gravity, magnetics and if the sedimentary basin is unknown, a site-specific stratigraphic well/s drilling operation is undertaken to confirm the existence of sedimentary basin / petroleum system delineated aerial geophysical data and other exiting geological data sets.

3. **Step 3**: Once the sedimentary basin has been confirmed and potential target area defined, ground geophysical surveys methods such as 2D seismic surveys are used in the search for...
potential geological structures that could hold economic oil or gas called reservoirs. This Environmental Impact Assessment (EIA) Report covers this Step 3.

4. **Step 4**: Exploration well drilling is undertaken on the identified geological structure (potential reservoir) based on the interpreted results of the seismic survey in order to test and confirm if the seismic survey delineated geological structure/s contains any oil or gas resources. If the drilled exploration well is dry it will be capped and abandoned safely, and.

5. **Step 5**: If there is oil or gas discovered during the exploration well drilling operations, then an appraisal well drilling operations may be undertaken to test the size and economics of the discovered oil or gas field. It is during the EIA for appraisal drilling for commercially discovered oil or gas and for possible production from either a conventional reservoir (with natural pores and permeability) or unconventional reservoir (natural pores but limited permeability) that one can now start to talk about fracking.

At present Namibia has no commercial or economic or even indicative oil or gas discovered onshore to frightened the public about nonexistence planned fracking. Fracking is not an exploration drilling technique but an oil or gas production method applied after a commercial proved discovery in a reservoir with poor permeability. Fracking relates to a Production License not an Exploration License that ReconAfrica is currently holding as granted by the Competent Authority, the Ministry of Mine and Energy. ReconAfrica holds a Petroleum Exploration License (PEL) No. 73 and this license is for exploration not for producing oil or gas through fracking.

### 1.2.2 Initial Exploration Period (4 years)

The initial exploration phase is a 4-year term with a one-year extension, with two potential renewal exploration extensions each of which are two years plus with an additional year extension. The spending commitment for the first phase was originally US$5 million plus an additional US$50,000 per year for the purpose of training and educating Namibians. In lieu of shooting a minimum 500 km of 2D seismic data, ReconAfrica had elected for a minimum two test wells to the base of the Karoo Super group. General market conditions allowed the Company to postpone the original program.

### 1.2.3 First Renewal Exploration Period

The first renewal exploration period of two (2) years is subject to possible one-year extension. In December 2019, the Company announced that its exploration license had been approved for the first renewal exploration period, which continues until January 25, 2022. During this period the Company must spend US$10 million, in addition to the US$50,000 per year for training and education for Namibians. The work program must acquire 250 kilometres of 2D seismic data and see the drilling and evaluation of either two (2) stratigraphic or exploration wells.

### 1.2.4 Second Renewal Exploration Period

The second renewal exploration period of two (2) years is subject to possible one-year extension. The second renewal period holds similar capital requirements and social programs to the first, with a requirement to acquire 200 km² of 3D seismic and drill and evaluate an initial delineation test.

### 1.2.5 Production License

If ReconAfrica’s exploration work leads to an economically viable project (discovery of economic oil and gas reserves), the Company may apply for a 25 year production license, which should be granted within 6 months of the date of application. The terms of the production license are a 5% royalty, and a 35% corporate tax rate. In addition, a three-tiered Additional Profits Tax (APT) is payable on the after-tax net cash if certain after tax, inflation adjusted rates of returns are met. The first hurdle rate is 15%, with the second and third tiers at 20% and 25%. Exploration, development and operating expenditures, as well as royalty and corporate income tax, are all fully deductible in the year they are paid in the computation of the APT net cash flow for the year. The first-tier rate of APT is established in the legislation (through a formula) at 25%. The incremental second and third tier APT rates are determined in the Petroleum Agreement, and in the case of Reconnaissance, are 28% and 29% respectively.
Figure 1.1: Hydrocarbon Map of Namibia (Source: www.namcor.com.na or www.mme.gov.na). Petroleum Licenses are granted as degree (Latitude and Latitude) Square Blocks and several such license have been granted both in the offshore and onshore environments. Plenty more blocks are open for anyone to apply if one has about N$2million yearly payment to lease such an area from the State inclusive of all other required mandatory State contributions.
Figure 1.2: Regional location of PEL No. 73 covering degree squares Blocks 1719, 1720, 1721, 1819, 1820 and 1821 and showing the Areas of Interest (AOI) (Kavango Sedimentary Basin), the proposed 2D seismic survey lines, regional council constituencies and traditional authorities boundaries.
1.3 Proposed 2D Seismic Survey, EIA, and SEA Considerations

1.3.1 Overview of ReconAfrica Exploration Activities

Following the granting of PEL 73 to ReconAfrica in 2015, the company purchased additional high resolution aeromagnetic data covering the license area and conducted a detailed analysis of the data, including the reprocessing and reinterpretation of all existing geological and geophysical data sets. This led to the identification of the Kavango Basin as the key Area of Interest (AOI) within PEL 73 as a potential sedimentary basin. A multiple stratigraphic well drilling programme has been implemented to confirm the existence of the Kavango Sedimentary Basin. Following on the drilling of the stratigraphic wells, the company intends to conduct 450km long of 2D seismic survey operations as part of the its exploration commitments and legal obligations as contained in the Petroleum Agreement. The proposed survey operations will be conducted along existing roads and tracks, using the Explorer 860 as the surface energy source and wireless receivers or geophones. The overall aim and objective of conducting the proposed 2D seismic survey operations, is to search for geological structures called reservoirs that may contain economic hydrocarbon. Depending on the outcomes of the proposed 2D seismic survey operations, exploratory well drilling operations over the delineated hydrocarbon structural reservoirs may be undertaken followed by appraisal well drilling operations if there is a discovery oil or gas.

1.3.2 Exploration Activities and Legal Relevance of the EIA Process

The proposed petroleum exploration activities (2D seismic Survey) by ReconAfrica are listed and requires an Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) to have been undertaken and Environmental Clearance Certificate (ECC) granted as provided for in the Environmental Management Act, 2007, (Act No. 7 of 2007) and Environmental Impact Assessment (EIA) Regulations, 2012 and within the additional legal framework of the Environmental Protection Clause 11 of the Petroleum Agreement, Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991), and the Petroleum Laws Amendment Act, 1998, (Act 24 of 1998).

The scope of this Environmental Impact Assessment (EIA) only covers the proposed 2D seismic survey as a listed exploration activity linked to the current exploration authorisation (PEL 73) as granted by the Competent Authority, the Ministry of Mines and Energy. This environmental assessment has nothing do with the production phase and possible method/s of oil or gas production that may be applicable because no oil or gas has been discovered and the Proponent does not have a Production License authorisation with listed activities that may require an ECC triggering the need for a production phase EIA process.

1.3.3 Strategic Environmental Assessments and Environmental Impact Assessment

1.3.3.1 Comparative Overview

Strategic Environmental Assessment (SEA) is a high-level tool which provides a systematic and comprehensive process of evaluating the environmental effects of a Policy, Plan or Programme (PPP) and the associated alternatives as may be applicable (Table. 1.1). The final goal of an SEA is to better reflect environmental aspects in formulating and deciding on Policies, Plans, and Programmes of Organs of State and, thereby, contribute to the sustainability and coexistence opportunities of various Government developmental strategies that eventually translates into projects. SEA reflects decisions by Organs of State such as the Ministry of Mines and Energy (MME) with respect to Policies, Plans and Programmes further upstream in the planning process, where decisions are being taken, that might influence project related decisions further downstream. EIA focuses on the downstream project level activities such as the ongoing exploration activities that ReconAfrica as the Proponent is currently undertaking or planning to undertake.

In this instance, the implementation of the National Policy, Plan or Programme on onshore oil and gas exploration by the MME (an Organ of State) with the overall objectives of attracting investment and development of the subsurface natural resources in Namibia for the benefits of its people, falls within
the higher level environmental management framework of an SEA while the key projects being implemented by various petroleum exploration companies (Proponents) hold PELs, including ReconAfrica, falls with the lower level sphere of an EIA (Table 1.1).

Table 1.1: Comparative summary overview of Strategic Environmental Assessment (SEA) and Environmental Impact Assessment (EIA).

<table>
<thead>
<tr>
<th>ASSESSMENT TYPE</th>
<th>ACTIVITY FOCUS</th>
<th>RESPONSIBILITY</th>
<th>OUTPUTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic Environmental</td>
<td>Policies</td>
<td>Organs of State (Line Ministries such as MME,</td>
<td>SEA Report with an Strategic Environmental</td>
</tr>
<tr>
<td>Assessment (SEA)</td>
<td>Plans</td>
<td>Parastatals, Regional Councils, Municipalities)</td>
<td>Management Plan (SEMP)</td>
</tr>
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<td></td>
<td>Programmes</td>
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</tr>
<tr>
<td>Environmental Impact</td>
<td>Project Specific</td>
<td>Proponent (Private person, private entity such</td>
<td>EIA Report with an Environmental Management</td>
</tr>
<tr>
<td>Assessment (EIA)</td>
<td>Activity</td>
<td>as ReconAfrica)</td>
<td>Plan (EMP)</td>
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1.3.3.2 Legislative Objects of Environmental Plans and SEA

Section 23 of Part VI of the Environmental Management 2007 (Act No. 7 of 2007) sets out the objects of environmental plans as follows:

(a) Co-ordinate and harmonise the environmental Policies, Plans, Programmes and decisions of the various Organs of State that exercise functions that may affect the environment or are entrusted with powers and duties aimed at the achievement, promotion, and protection of a sustainable environment, in order to:

   (i) Minimise the duplication of procedures and functions, and.

   (ii) Promote consistency in the exercise of functions that may affect the environment.

(b) Enable the Minister to monitor the achievement, promotion, and protection of a sustainable environment.

The Environmental Management 2007 (Act No. 7 of 2007) does not mention SEA. However, in practices the preparation of an Environmental Plan with respect to a Policy, Plan or Programme for an Organ of State referred to in Section 23 of Part VI of the Environmental Management Act 2007, (Act No. 7 of 2007) can only be achieved by undertaking a SEA study. In other words, the SEA study is a key tool that can be used to develop an Environmental Plan a Policy, Plan or Programme of an Organ of State.

Responsibilities for the implementation of Environmental Plans / SEA are only for Organs of State such as Line Ministries, Agencies, Regional Councils and Larger Municipalities and it is not for the Proponents such as ReconAfrica. The Organ of State may delegate the task of preparing an Environmental Plan to an Environmental Assessment Practitioner (EAP). An Environmental Plan is restricted to Organs of State with functions of Policies, Plans, Programmes, which have effects on the environment. According to Subsection 24 (1) of the Environmental Management 2007, (Act No. 7 of 2007), the Minister may identify and list by notice in the Gazette or by regulation organs of state which are exercising functions that may affect the environment.

Every Organ of State identified and listed in terms of Subsection 24 (1) of the Environmental Management 2007, (Act No. 7 of 2007), will be required to prepare an environmental plan in the prescribed form and manner. The Act further states that every Organ of State contemplated in subsection (1), must in the preparation of an environmental plan take into consideration every other environmental plan already adopted with a view to achieving consistency among such plans. However, such a list or gazetted or regulatory list of Organs of State with functions that may affect the environment...
has not yet been developed within the framework of the Environmental Management 2007 (Act No. 7 of 2007).

In line with the provisions of the Environmental Management 2007 (Act No. 7 of 2007), in 2015, and then the Ministry of Lands and Resettlement as an Organ of State prepared Intergraded Land Use Plans for Kavango East and West Regions. However, the Integrated Land Use Plans failed to consider the likelihood for subsurface resources such as oil, gas or minerals potentially occurring in Kavango East or West Regions and failed to provide consistency with the Ministry of Mines and Energy Policies, Plans, Programmes as contemplated in the Environmental Management 2007, (Act No. 7 of 2007).

1.3.3.3 EIA as an Appropriate Assessment Tool for ReconAfrica Exploration Activities

As shown in Table 1.1, ReconAfrica as a Proponent undertaking exploration operations in PEL 73 over a site-specific key area of interest at local project level activities is subject to undertaking an EIA and EMP to obtain an ECC for the exploration listed activity as may be applicable. The activities of ReconAfrica do not fall at the high level of Policies, Plan or Programmes that are run by Organs of States and subject to an SEA but a lower project activity level run by Proponents and subject to EIA and EMP (Table 1.1).

ReconAfrica as a Proponent is under no obligation to undertake an SEA and the SEA will be irrelevant to a site-specific project level exploration activity being undertaken in the localised Area of Interest within PEL 73.

High level Integrated Land Use Plans (Environmental plans) were prepared for the regions in 2015 but unfortunately the plans did not take into considerations the opportunities for subsurface resources occurring in both Kavango West and East regions and the need to assess the Ministry of Mines and Energy Policies, Plans and Programme coexistence.

1.3.4 Purpose of this EIA Report

This Environmental Impact Assessment (EIA) report is prepared in accordance with the regulatory requirements as provided for in the Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991), Environmental Impact Assessment (EIA) Regulations, 2010 and Environmental Management Act (EMA), 2007, (Act No. 7 of 2007). The overall aims of this EIA report have been to assess and document the key issues and impacts that the proposed project activities (2D Seismic Survey) will have on the receiving environment covering the physical, socioeconomic, and biological environments of the project area as defined during the scoping phase (Annex 1).

Appropriate mitigation measures for potentially significant environmental impacts are detailed in Environmental Management Plan (EMP) report for implementation by the Proponent. The objectives of this EIA study have been to:

(i) Identify, evaluate, potential environmental impacts of the proposed project on the receiving environment.

(ii) Assess and analyse the environmental costs and benefits associated with the proposed 2D seismic survey operations project.

(iii) Ensure that concerns and aspirations of the local community are addressed in all stages of the proposed 2D seismic survey operations.

(iv) Evaluate coexistence opportunities of the proposed 2D seismic survey and existing and future land uses.

(v) Propose mitigation and monitoring measures that will reduce negative impacts and enhance the positive ones.
1.4 Project Location

1.4.1 License Area (PEL), Exploration Areas of Interest and Oil or Gas Field

Although a PEL may be a very large area defined by the Degree Square Blocks which is good for the State in terms of the subsurface annual rental income, the key area of interest (Sedimentary Basin) is usually highly localised and controlled by the regional and local geology and petroleum system not the boundary of the license area and its proximity to a sensitive area (Fig 1.3).

It is the proximity of the AIO boundary to a sensitive area that is important. Within a PEL area, a local AIO is often delineated based on the interpretation of technical data and in an event of a commercial discovery, oil, or gas field area within the AIO becomes even more smaller than the AIO. Within the PEL, AIO or oil or gas field boundaries, only localised areas are affected especially where the actual activities are taking place that defines the actual surface footprint of the operation.

An oil or gas field within an AIO can only be delineated following a commercial discovery and completion of an appraisal well drilling and testing operation before actual field development can even be contemplated. An oil or gas field is a localised area within the entire AIO which is used for producing oil or gas.

1.4.2 PEL 73 License Area

The PEL 73 granted as a Degree Square Blocks as provide for in the Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991) covers an area of approximately 25,341.33 sq km (6.3 million acres) (Figs. 1.2 and 1.3). PEL No. 73 covering Blocks 1719, 1720, 1721, 1819, 1820 and 1821 falls within the Kavango Basin forming part of the greater Etosha Basin of northern Namibia falling within the greater Kalahari Sediments of Southern Africa.

1.4.3 The Area of Interest (AOI) Within PEL 73

The Area of Interest (AOI) within PEL 73 delineated from the interpretation of the aerial geophysical data covering the Kavango West and East Regions is not on the banks of the Okavango River, not related to the Okavango Delta, does not cover the archaeological sites and Tsodilo Hill which is in Botswana and do not fall in sensitive or proclaimed national park.

Current key exploration interests in Kavango West and East Regions are situated about 55 km south of Rundu, 80 km south of the Okavango River, more than 260 km from the Okavango Delta in Botswana and not related to the Delta whatsoever, more than 40 km from the boundary of the Khaudum National Park and more than 70 km from the Mangetti National Park. The overall general area falls in the communal areas of the Ncamangoro and Mashare Constituencies of the Kavango West and East Regions, respectively. Ncamangoro and Mashare Constituencies falls within the boundaries of the Mbunza and Sambyu Traditional Authorities, respectively.

The proposed 2D seismic survey will cover the AOI not the entire PEL 73. Extension of the survey lines beyond the AOI will be undertaken only to fully understand the possible subsurface structural closures and search for potential reservoirs that may be associated with the basin margins (Fig. 1.3).
1.4.4 Location of the Proposed 2D Seismic Survey Lines

PEL 73 and the proposed 2D seismic survey area covers parts of both the Kavango West and East Regions in northern Namibia (Fig. 1.4). Within the key areas of interest, the following tribal (traditional) authorities falls within the Kavango East Region: Shambyu, Gciruku and Mbukushu tribal authorities (Fig. 1.4). The following is the summary of the detailed locations of the proposed 2D seismic survey lines with respect to the regional and traditional authorities administrative / governance boundaries as shown in Figs. 1.2 and 1.4 and Plates 1.1 -1.32):

(i) Line NS-1: Covers Kavango East and West Regions; Ncuncuni, Ncamagoro and Mashare Constituencies; and Mbnunza and Shambyu Traditional Authorities (Fig. 1.4 and Plates 1.1 -1.4).

(ii) Line NS-2: Covers Kavango East Region; Mashare Constituency; and Shambyu Traditional Authority (Fig. 1.4 and Plates 1.5 -1.8).
(iii) Line NS-3: Covers Kavango East Region; Ndiyona Constituency; and Gciruku Traditional Authority (Fig. 1.4 and Plate 1.9).

(iv) Line NS-4: Covers Kavango East Region; Mashare and Ndonga Linena Constituencies; and Shambyu Traditional Authority (Fig. 1.4 and Plates 1.10 and 1.11).

(v) Line NS-5: Covers Kavango East Region; Rundu Rural Constituency; and Shambyu Traditional Authority Fig. 1.4 and Plates 1.12 -1.14).

(vi) Line EW-1: Covers Kavango East and West Regions; Ncuncuni, Rundu Rural and Mashare Constituencies; and Mbuza and Shambyu Traditional Authorities (Fig. 1.4 and Plates 1.15 -1.17).

(vii) Line EW-2: Covers Kavango East Region; Mashare Ndonga Linena and Ndiyona Constituencies; and Shambyu and Gciruku Traditional Authorities (Fig. 1.4 and Plates 1.18-1.20).

(viii) Line EW-3: Covers Kavango East and West Regions; Ncuncuni, Rundu Rural and Mashare Constituencies; and Mbuza and Shambyu Traditional Authorities (Fig. 1.4 and Plates 1.21 -1.25).

(ix) Line EW-4: Covers Kavango West Region; Ncuncuni Constituency and Mbuza Traditional Authority (Fig. 1.4 and Plates 1.26 -1.28).

(x) Line EW-5: Covers Kavango West and East Regions; Ncamagoro, Ncuncuni and Mashare Constituencies and Mbuza and Shambyu Traditional Authorities (Fig. 1.4 and Plates 1.29-1.31), and.

(xi) Plate 1.32 shows one of the alternatives survey line EW with other alternative survey lines shown in Fig. 1.4.

1.4.5 Accessibility

The main access to the survey area can be undertaken by 4 by 4 vehicles either through the already exiting gravel roads, sandy roads and tracks connecting small settlement (Figs. 1.4 and 1.5 and Plates 1.1 -1.32). The survey area and all the profiles / survey lines do follow existing road or tracks (Fig. 1.4 and Plates 1.1 -1.32). Very few areas along the survey lines will require the widening of the existing sandy access resulting in cutting of the local bushes. No big trees shall be cut unnecessary because of widening access because no new cut line will be created. The survey will be conducted from the month of April which is the dry season with no effect on the local subsistence farmland. The location of the proposed profiles / survey lines follows existing tracks and are based on the results of the field-based scouting and verification undertaken by Risk-Based Solutions team during the months of November and December 2020 and January 2021 (Plates 1.1-1.32).

1.4.6 2D Seismic Survey Operations and Alleged Communities Relocations

Onshore seismic survey operations have been undertaken in Namibia for many years and the latest being the 2017 2D seismic survey operations that was conducted by ACREP in PEL 72 covering Kavango West Region. During any oil and gas exploration programme no community relocation whatsoever does take place and no one will be relocated or displaced during the proposed 2D seismic survey operations to be conducted along existing roads and tracks. Community relocations are rarely undertaken even during the oil or gas field development stages following a commercial discovery and such instances may only affect a community settlement that may be located too close to a critical oil and gas supporting infrastructure that cannot be situated anywhere within the discovered oil or gas field. Such infrastructure may include a production well/s, pipeline, power station, refinery or any other supporting infrastructure to the oil or gas field development and operational safety requirements. Such issues will indeed be addressed in a separate environmental assessment that may be implemented for the production phase of any discovered oil or gas resources.
Figure 1.4: Detailed location of the key exploration Areas of Interest (AOI) and proposed and alternative 2D seismic survey lines along exiting roads and tracks with respect to the various regional and traditional authorities and settlements.
Figure 1.5: Field-based verified existing access roads and tracks to be used for the proposed 2D seismic survey lines.
Plate 1.1: Northern section of the proposed 2D seismic survey Line NS-1 detailed location shown by a drone aerial view to the south along the D3425 road from Rundu to Ncaute.
Plate 1.2: Middle section of the proposed 2D seismic survey Line NS-1 detailed location near Hamoye shown by a drone aerial view to the south along the D3425 road from Rundu to Ncaute.
Plate 1.3: Southern middle section of the proposed 2D seismic survey Line NS-1 detailed location shown by a drone aerial view to the north (towards Ncaute) along the D3425 road near Gcaru and west of the Omatako Ephemeral River Channel.
Plate 1.4: Southern end-section of the proposed 2D seismic survey Line NS-1 detailed location shown by a drone aerial view to the north along the D3425 road near Namkaub at the junction of the track leading to the northern boundary of the Manetti National Park.
Plate 1.5: Northern section of the proposed 2D seismic survey Line NS-2 detailed location shown by a drone aerial view to the north (towards Dove) along the existing tracks linking Dove to the D3400.
Plate 1.6: Northern section of the proposed 2D seismic survey Line NS-2 detailed location shown by a drone aerial view to the south (towards D3400 Road junction) along the existing tracks linking Dove to the D3400.
Plate 1.7: Middle section of the proposed 2D seismic survey Line NS-2 detailed location shown by a drone aerial view to the north along the D3400 Road towards junction with the existing tracks linking Dove to the D3400.
Plate 1.8: Middle section of the proposed 2D seismic survey Line NS-2 detailed location shown by a drone aerial view to the south along the existing track linked to the D3400.
Plate 1.9: Northern section of the proposed 2D seismic survey Line NS-3 detailed location shown by a drone aerial view to the south along the existing 4 by 4 sandy track linking Khaudum National Park to the B8 at Katere.
Plate 1.10: Northern section of the proposed 2D seismic survey Line NS-4 detailed location shown by a drone aerial view to the south along the D3400 linked to the B8.
Plate 1.11: Middle section of the proposed 2D seismic survey Line NS-4 detailed location shown by a drone aerial view to the south along the D3400 linked to the B8.
Plate 1.12: Northern section of the proposed 2D seismic survey Line NS-5 detailed location shown by a drone aerial view to the south along the new Rundu to Mbambi Roads D3448.
Plate 1.13: Middle section of the proposed 2D seismic survey Line NS-5 detailed location shown by a drone ground view to the east showing the new Rundu to Mbambi Roads D3448 and D3468 from the junction to Cuma along the new D3401 Road.
Plate 1.14: Southern section of the proposed 2D seismic survey Line NS-5 detailed location shown by a drone ground view to the south (Kawe) between Mbambi and the D3400 Road near Kawe.
Plate 1.15: Western section of the proposed 2D seismic survey Line EW-1 detailed location shown by a drone aerial view to the east along the new D3401 Road from Ncuncuni to Cuma passing through the community forestry.
Plate 1.16: Middle section of the proposed 2D seismic survey Line EW-1 detailed location shown by a drone aerial view at Cuma towards the west along the new D3401 Road from Ncuncuni to Cuma passing through the community forestry.
Plate 1.17: Eastern section of the proposed 2D seismic survey Line EW-1 detailed location shown by a drone aerial view to the east at cross cutting with NS-5 at the Rundu to Mbambi Roads D3448 and D3468 from the junction to Cuma along the new D3401 Road.
Plate 1.18: West section of the proposed 2D seismic survey Line EW-2 detailed location shown by a drone aerial view to the east along the D3400 and passing through the community forestry.
Plate 1.19: Western section of the proposed 2D seismic survey Line EW-2 detailed location shown by a drone aerial view to the east from the D3400 junction with the road to Taratara. This road is recommended as the alternative survey line for the EW-2 for the eastern section.
Plate 1.20: Eastern section of the proposed 2D seismic survey Line EW-2 detailed location shown by a drone aerial view at Taratara looking towards west and along the recommended alternative survey line towards D3400 from Taratara.
Plate 1.21: Western section along D3400 Road of the proposed 2D seismic survey Line EW-3 detailed location shown by a drone aerial view to the south toward Ncaute along the D3400 Road.
Plate 1.22: Middle section of the proposed 2D seismic survey Line EW-3 detailed location shown by a drone aerial view to the east along the D3400 Road from Kawe settlement.
Plate 1.23: Middle section of the proposed 2D seismic survey Line EW-3 detailed location shown by a drone aerial view to the west along the D3400 Road at Kawe wood processing facility.
Plate 1.24: Middle eastern section of the proposed 2D seismic survey Line EW-3 detailed location shown by a drone aerial view taken at Mutwegombahe towards the western direction (towards Kawe and current drilling location 1) along the D3400 Road.
Plate 1.25: Middle eastern section of the proposed 2D seismic survey Line EW-3 detailed location shown by a drone aerial view at Mutwegombahe towards the east along the D3400 Road.
Plate 1.26: Eastern section of the proposed 2D seismic survey Line EW-4 detailed location shown by a drone aerial view to the east from the B8 Road. The EW-4 survey line run through an existing Community Forestry track to Hamoye along the D3400 Road from Rundu to Ncaute.
Plate 1.27: Middle section of the proposed 2D seismic survey Line EW-4 detailed location shown by a drone aerial view to the northeast within the middle of the community forestry. The EW-4 survey line run through an existing Community Forestry track to Hamoye along the D3400 Road from Rundu to Ncaute.
Plate 1.28: Eastern-section of the proposed 2D seismic survey Line EW-4 detailed location shown by a drone aerial view to the west through the community forestry near Hamoye along the D3400 Road from Rundu to Ncaute.
Plate 1.29: Western-section of the proposed 2D seismic survey Line EW-5 detailed location shown by a drone aerial view to the east along the existing track from the B8 junction to Gcaru through Šivaradi.
Plate 1.30: Western-section of the proposed 2D seismic survey Line EW-5 detailed location shown by a drone aerial view to the east along the existing track from the B8 junction to Gcaru through Sivaradi.
Plate 1.31: Eastern-section of the proposed 2D seismic survey Line EW-5 detailed location shown by a drone aerial view to the west along the existing track from Gcaru to Sivaradi.
Plate 5.32: Access track linking the D3425 to the B8 tarred Road from Grootfontein to Rundu passing north of Mangetti National Park is an alternative potential East-West seismic survey line if required. This specific track was inspected by the Ministry of Environment, Forestry and Tourism team during the field familiarisation / inspection visit undertaken on the 18th and 19th January 2021 to the project area.
1.5 Onshore Petroleum Exploration History

1.5.1 Overview of Onshore Petroleum Exploration History

Onshore oil and gas exploration in Namibia began with the drilling of the Berseba-1 well in the southern Nama Basin in 1928 by South West Africa Petroleum based on surface geology studies, which included the visibility of bitumen veins in outcrops, but was uncommercial (Miller, 1992). According to Miller (1992), Owambo (Etosha) Basin has been held under concession by Etosha Petroleum since 1959. The Owambo Basin in the north saw activity initiated in the early 1960s with a focus on early vintage potential fields data, including gravity and magnetic data, surface geology and outcrop mapping, soil gas geochemical sampling, augmented with limited 2D seismic acquisition and interpretation, and the drilling of four critical deeper wells (ReconAfrica, 2020).

1.5.2 History of Petroleum Exploration in Northern Onshore Namibia

The following is the summary history on oil and gas exploration activities covering aerial and ground geophysical survey (Aeromagnetic, gravity and seismic surveys) and well drilling operations in northern onshore Namibia inclusive of the newly discovered Kavango Basin by ReconAfrica (Figs. 1.6 – 1.8, Miller, 1992; Hoak, et. al, 2014 and ReconAfrica, 2020):

(i) Aeromagnetic, Gravity and Seismic Survey conducted in northern Namibia since 1962 (Figs. 1.6 – 1.18):

- 1962: Regional Aeromagnetic survey by Texas Eastern.
- 1963: Ground-based gravity survey by Ray Geophysical.
- 1990: 2D seismic by Overseas Petroleum Investment Corporation (OPIC).
- 1990: Aerogravity data by Overseas Petroleum Investment Corporation (OPIC).
- Since 1992: Namibian Government with support from the European Union and Germany Government has acquired high resolution magnetic and radiometric data over the whole, country as well as gravity, electromagnetic and hyperspectral data sets on selected areas.
- 2003: Aeromagnetic and gravity survey conducted by First African Oil (circle Oil).
- 2012: Aeromagnetic and gravity survey conducted by Preview Energy (Pty) Ltd (Permitting and technical support provided by Risk-Based Solutions).
- 2013: Aeromagnetic and aerogravity survey by Hydrocarb Energy, and.
- 2018: 2D seismic survey by Acrep Exploracao Petrolifera SA (Environmental permitting and monitoring support provided by Risk-Based Solutions).

(ii) Other petroleum exploration method conducted in northern Namibia since 1967:

- 1967: Regional surface geochemistry study by Etosha Petroleum.
2010: Apatite Fission Track Analysis (AFTA) from the Etosha Strat Test #1 and 5-1A wells study conducted by Preview Energy (Pty) Ltd (Permitting and technical support provided by Risk-Based Solutions).

2012: Field-based outcrops sampling for source and reservoir rocks by Preview Energy (Permitting and technical support provided by Risk-Based Solutions).

2012 and 2013: Field-based outcrops sampling for source and reservoir rocks by Hydrocarb Energy.

2012: Limited soil gas survey by Frontier Resources west of PEL 73 in PEL 72.

2015: ReconAfrica purchased additional high resolution aeromagnetic data covering the Licensed Property and conducted a detailed analysis of the resulting data and other available data related to the block, including reprocessing and reinterpretation of all existing geological and geophysical data. This led to the identification on the Licensed Property of the Kavango Basin, and.

2018: Geochemical soil sampling by Acrep Exploracao Petrolifera SA (Permitting and additional support provided by Risk-Based Solutions).

Well drilling operations conducted in northern Namibia since 1964 (Fig. 1.6):

1964: Stratigraphic Test #1 well (Total Depth 1890 m) was drilled by Etosha Petroleum.

1970: Etosha 1-1 (Total Depth 1593 m) and 2-1 (Total Depth 1235 m) wellbores two shallow wells and one deeper test and the Etosha 5-1A (Total Depth 2523 m) deeper test were drilled by Etosha Petroleum, and.

2020: ReconAfrica proposed to drilled two (2) ï three (3) stratigraphic wells to confirm the presence of the newly discovered Kavango Basin.
Figure 1.6: Digital elevation model of Owambo (Etosha) Basin showing the historical magnetic/gravity survey boundaries, seismic grid, and well locations (Source: Hoak, et. al., 2014).
Figure 1.7: Overview of the existing geophysical Government data coverage over Namibia (Source: www.mme.gov.na).
Figure 1.8: Historical seismic survey in the general area showing the location of the recent, 2018, 2D seismic survey that was conducted by CGG using Vibroseis trucks on behalf of the license holder Acrep covering PEL 72 situated west of PEL 73. With the permitting and monitoring support by Risk-Based Solutions team, the ground seismic survey was conducted successfully with the participation of the local communities along the survey lines and witnessed in the field by the Hon. Governor of the Kavango West Region, Councillors, and traditional authorities. Similar field-based organisation arrangements will be adopted for the proposed 2D seismic survey in PEL 73 by ReconAfrica.
1.6 Structure of the Report

The following is the summary structure outline of this EIA report with respect to the proposed 2D seismic survey operations:

× **Section 1: Project Background** covering Introduction, Summary of ReconAfrica Exploration Commitment and legal Obligations, Detailed location of the proposed 2D Seismic Survey Lines and history on oil and gas exploration in Namibia.

× **Section 2: EIA Approach and Methodology** covering summary of the Terms of Reference, environmental assessment process and step, public and stakeholder consultation approach, impact assessment and mitigation measure.

× **Section 3: Description of the Proposed Project** covering origin of oil and gas and description of the proposed 2D seismic survey.

× **Section 4: Regulatory Framework** providing detailed description of the applicable legislations and permitting requirements.

× **Section 5: Receiving Environment** covering physical environment (climate, water, air quality, and geology), Biological environment (flora, fauna and ecosystem services and functions) and socioeconomic environment around the proposed survey area with special focus around the Area of Interest (AOI).

× **Section 6: Assessment of Likely Impact** covering assessment procedure, likely and overall summary of impacts associated with the proposed 2D seismic survey activities on the receiving environment, and.

× **Section 7: EIA Conclusions and Recommendations** covering the key issues identified and summarised recommendations.
2. **EIA APPROACH AND METHODOLOGY**

2.1 **Summary EIA Terms of Reference (ToR)**

Summary of the proposed activities, alternatives and key issues considered during the Environmental Assessment (EA) process are summarised in Table 2.1. The EIA process was performed by a fully qualified and experienced team, objectivity and reasonable skill, care and diligence in accordance with professional standards and practices existing at the date of performance of the assessment and that the guidelines, methods and techniques used and applied in this study conformed to the national regulatory requirements, process and specifications in Namibia and in particular as required by Ministry of Mines and Energy (MME), Ministry of Environment, Forestry, and Tourism (MEFT) and the client (Proponent). The preparation of this EIA report was undertaken in line with the January 2015 MEFT Environmental Assessment Reporting Guideline.

Table 2.1: Summary of the proposed activities, alternatives and key issues considered during the Environmental Assessment (EA) process covering EIA.

<table>
<thead>
<tr>
<th>PROPOSED 2D SEISMIC SURVEY PROJECT ACTIVITIES</th>
<th>ALTERNATIVES CONSIDERED</th>
<th>KEY ISSUES EVALUATED AND ASSESSED IN THIS EIA REPORT WITH MITIGATION MEASURES PROVIDED IN THE ENVIRONMENTAL MANAGEMENT PLAN (EMP) REPORT</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) Planning and mobilisation (Pre-survey preparation).</td>
<td>(i) Survey location with respect to the PEL and Area of Interest (AOI)</td>
<td>Potential land use conflicts / opportunities for coexistence between proposed exploration and other existing land uses such as agriculture, community forestry, timber harvesting conservation and tourism</td>
</tr>
</tbody>
</table>
| (ii) Camp sites setups and widening of tracks and creation of limited new access as may be applicable. | (ii) Profiles / survey lines length and location | 1. Water quality  
2. Physical infrastructure and resources  
3. Air quality, noise, and dust  
4. Landscape and topography  
5. Soil quality  
6. Climate change influences. |
| (iii) Actual data acquisition, and. | (iii) Energy source (Vibroseis, Explorer 860 or dynamite) | | |
| (iv) Demobilisation and Closure (Survey Completion). | (iv) Receivers / Geophones (Wireless or Cabled) | | |
| | (v) No-Action alternative, proposed survey not going ahead | Biological Environment |
| | (vi) Other alternative land, roads and tracks uses | 1. Habitat  
2. Protected areas and resources  
3. Flora  
4. Fauna  
5. Ecosystem functions, services, use values and non-use or passive use. |
| | (vii) Ecosystem Function (What the Ecosystem Does) | Socioeconomic, cultural, and archaeological environment |
| | (viii) Ecosystem Services | 1. Local, regional, and national socioeconomic settings  
2. Subsistence agriculture  
3. Community forestry  
4. Tourism and recreation  
5. Cultural, biological, and archaeological resources |
| | (ix) Use Values | | |
| | (x) Non-Use, or Passive Use | Environmental Management Plan (EMP) Providing Mitigation Measures and Monitoring Plan |
| | (xi) The No-Action Alternative | Mitigation shall focus on the following in order of preference:  
1. Enhancement, e.g. provision of new habitats and local additional infrastructure through clearing appropriate tracks that local community can use to improve accessibility in area;  
2. Avoidance, e.g. use of only existing roads, tracks and disturbed areas and use of alternative equipment design such as the use of Explorer 860 instead of Vibroseis to avoid effects on ecological receptors;  
3. Reduction, e.g. limitation of effects on receptors through survey design changes; and  
4. Compensation, e.g. Payments on crop fields and improved accessibility for the local communities. |
2.2 Overview of the EIA Methodology

The Environmental Assessment process for this project has been undertaken in accordance with the applicable regulations and assessment procedure as shown in Fig. 2.1. The assessment process also took into considerations Reconnaissance Energy Namibia (Pty) Ltd corporate governance requirements as well as all other relevant Namibian laws, regional (Southern Africa Development Community – SADC) and international environmental and petroleum exploration protocols, standards, and practices applicable for onshore oil and gas well drilling operations.

The general framework of the baseline data collection was as follows:

- Scoping (determination of geographical and other boundaries; preliminary assessment).
- Review of existing regulatory framework and institutional arrangements.
- Local community and stakeholder mapping and pre-consultation for the local community and regional leadership.
- Public and stakeholder consultation process.
- Field verifications and detailed field-based environmental assessments.
- Reporting, impact identification and development of suggested mitigation measures, and.
- Reporting, development of an Environmental Management Plan (EMP) with roles and responsibilities.

Prior to the field study, a desktop studies were conducted to review the available reports, and to design plans and maps to compile relevant biophysical and socioeconomic information of the project area. Biophysical studies covered environmental aspects such as physiography, climate, hydrology, drainage, soils, geology/hydrogeology, land use, vegetation, wildlife, and socioeconomic environment.

The socio-economic environmental study covered information on issues such as population, literacy, social amenities (healthcare and schools), land use, land tenure, the social dimensions of wellbeing and income levels, water supply, sanitation levels and security, along with other pertinent issues. The field-based study also used to validate the data compiled during the desktop study.

2.3 Summary of the Environmental Assessment Process

2.3.1 Summary of the Assessment Step

The EIA and EMP process used for this project took into considerations the provisions of the Environmental Impact Assessment (EIA) Regulations, 2012 and the Environmental Management Act (EMA), 2007, (Act No. 7 of 2007) as outlined in Fig. 2.1. The environmental assessment steps undertaken or still to be taken are summarised as follows (Fig. 2.1):

(i) Project screening process (Undertaken in November 2020).

(ii) Preparation of the Draft BID/Draft Scoping Report with Terms of Reference (ToR) for review by the Proponent (Undertaken in December 2020).

(iii) Preparation of the Public Notice published in the local newspapers as part of required public consultation process (Undertaken in December 2020).

(iv) Project registration / notification through the completion of the online formal registration / notification form on the MEFT online Portal (www.eia.met.gov.na), together with the hardcopies of the Draft BID/Scoping Report with ToR submitted to the Environmental
Commissioner in the MEFT through the Ministry of Mines and Energy (MME) Director of Energy (Competent Authority) for review (Undertaken in January 2021).

(v) Opened the Stakeholder register (Undertaken in January 2021).

(vi) Invitation / notices to stakeholders and the general public to participate in environmental assessment process issued through the local newspaper advertisements as well as via direct emails communications to key stakeholders institutions such as Line Ministries, Regional and Local Governments as may be applicable (Undertaken in January-February 2021 for a period of 21 days from the 1st publication published on the 7th January 2021). Public consultation period was extended to the 12th February 2021.

(vii) Preparation of the Draft EIA and EMP Reports (Undertaken in February and March 2021).

(viii) Preparation of the Final EIA and EMP Reports (Undertaken in March 2021).

(ix) The final EIA and EMP reports submitted to the Environmental Commissioner in MEFT through the MME (Competent Authority) in fulfilment of all the requirements of the Environmental Impact Assessment (EIA) Regulations No. 30 of 2012 and the Environmental Management Act, (EMA), 2007, (Act No. 7 of 2007) for application of the Environmental Clearance Certificate (ECC) for the proposed project (March 2021).

(x) Following the submission of the application for ECC to the Environmental Commissioner, the public and stakeholders who are interested or affected by the proposed project given additional fourteen (14) days to submit comments / inputs about the proposed project direct to the Environmental Commissioner when the application is made available for additional comments / inputs by the Environmental Commissioner on the MEFT digital Portal www.eia.met.gov.na, and.

(xi) Wait for the Records of Decision (RD) from the Environmental Commissioner (From March 2021).

2.3.2 Assumptions and Limitations

The following assumptions and limitations underpin the approach adopted, overall outcomes and recommendations of the environmental assessment process and this EIA Report:

❖ The proposed 2D seismic Survey activities as well as all the plans, maps, PEL, Area of Interest, profiles / survey line boundary / coordinates, and appropriate data sets received from the Proponent, project partners, regulators, Competent Authorities, and specialist consultants are assumed to be current and valid at the time of conducting the studies and preparation of this EIA Report.

❖ The impact assessment outcomes, mitigation measures and recommendations provided in the EIA and EMP Reports are valid for the lifecycle or repeat of the proposed 2D seismic survey operations.

❖ A precautionary approach has been adopted in instances where baseline information and impact assessment guidelines were insufficient or unavailable or site-specific project activities were not yet available, and.

❖ Mandatory timeframes as provided for in the EIA Regulations No. 30 of 2012 and the EMA, 2007, (Act No. 7 of 2007) have been observed.
1. PROPONENT PROJECT IDENTIFICATION, SCREENING AND REGISTRATION

Project registration with the Office of the Environmental Commissioner in the Ministry of Environment, Forestry and Tourism (MEFT). Completed the Online Environmental Clearance Certificate (ECC) Application Form and Background Information Document (BID) and CV uploaded on the MEFT digital platform at www.eia.met.gov.na

2. ENVIRONMENTAL COMMISSIONER PROJECT SCREENING

Environmental Commissioner (EC) Screen the Application and advise in terms of Section 33 of Environmental Management Act, 2007, (Act No. 7 of 2007)

3A. ENVIRONMENTAL CLEARANCE CERTIFICATE (ECC) AND ENVIRONMENTAL ASSESSMENT REQUIRED

Where an Environmental Assessment is required, prepare Draft reports as may be applicable (BID, Draft Scoping, EIA and EMP Report) including Specialist Studies

3B. ECC AND ASSESSMENT NOT REQUIRED

4. PUBLIC AND STAKEHOLDER CONSULTATIONS

Undertake Public and Stakeholder Consultation Process including publishing of notices in three (3) Newspapers for three (3) consecutive weeks and public meetings as may be applicable.

5. STAKEHOLDER CONSULTATIONS, ENGAGEMENT, ASSESSMENT PROCESS AND REPORTING

Continue with stakeholder consultation and engagement and assessment process taking into consideration their inputs and what the proposed project activities will have on the receiving environment (physical, biological, socioeconomic, cultural / archaeological and ecosystem). Prepare final BID/Scoping and EIA and EMP Reports including the outcomes of the Public and Stakeholder Consultation Process for further review

6. GOVERNMENT LODGEMENT

HARDCOPIES: Completed ECC Application Form with Revenue Stamps, Finalise the BID, Scoping, EIA and EMP based on the outcomes of the Public and Stakeholder Consultation Process submitted to EC in MEFT through the Competent Authority. The Competent Authority will forward the application to the EC in terms of Section 32 of Environmental Management Act, 2007, (Act No. 7 of 2007)

DIGITAL UPLODES: Completed ECC Application Form with Revenue Stamps, Finalise the BID, Scoping, EIA and EMP based on the outcomes of the Public and Stakeholder Consultation Process uploaded on the MEFT digital platform at www.eia.met.gov.na

Proponent may resubmit any outstanding documentation if any

7. EC 14 DAYS PUBLIC AND STAKEHOLDER CONSULTATIONS

The Environmental Commissioner, will acknowledge receipt of the report (Reg 16) and assess its compliance to the Act and subject the report to further public and stakeholder scrutiny for fourteen (14) days. Interested and Affected Parties will have access to the report on the MEFT digital platform at www.eia.met.gov.na

8. RECORDS OF DECISIONS (RoDs)

Decision taken and the Proponent informed in terms of Section 37 of the Environmental Management Act, 2007, (Act No. 7 of 2007)

9. ECC NOT GRANTED

May Appeal to the Minister of Environmental, Forestry and Tourism Or Approach the Courts for litigation

9A. ECC IS GRANTED

Conditions of Approval, and Environmental Monitoring be implemented by the Proponent and to support ECC Renewal once it expires

Figure 2.1: RBS Schematic presentation of Namibia’s Environmental Assessment Procedure.

2.4 Public and Stakeholder Consultation Process

2.4.1 Overview

In line with the provisions of the Environmental Impact Assessment (EIA) Regulations, 2012 and the Environmental Management Act (EMA), 2007, (Act No. 7 of 2007 extensive and well attended public, stakeholders and regulatory consultations were undertaken during the months January and February 2021. Public notices were published in the local newspapers. Public meetings were organised in the
City of Windhoek, Town of Nkurenkuru, Town of Rundu and the following settlements in Kavango East and West Regions: Sivaradi 1 and 2, Gcaru, Ncuncuni, Ncaute, Makandina, Mutwegombahe, Mbambi and Cuma.

2.4.2 List of Potential Stakeholders

Prior to the implementation of the consultation process and as part of the scoping phase, potential stakeholder groups with respect to the proposed 2D seismic survey operation in PEL 73 were identified as presented in Table 2.2 and summarised as follows:

(i) Central Government (Key line Ministries).
(ii) Regional Councils in Kavango West and East Regions.
(iii) Constituency for Kavango West and East Regions.
(iv) Traditional / Tribal Authorities in Kavango West and East Regions.
(v) Local communities.
(vi) Project personnel.
(vii) NGOs and conservation organisations, and.
(viii) General public / Other interested parties.

Table 2.2: List of stakeholder groups identified.

<table>
<thead>
<tr>
<th>STAKEHOLDER GROUP</th>
<th>STAKEHOLDERS CATEGORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Government Ministries</td>
<td>Ministry of Mines and Energy (MME)</td>
</tr>
<tr>
<td></td>
<td>Ministry of Environment, Forestry and Tourism (MEFT)</td>
</tr>
<tr>
<td></td>
<td>Ministry Urban and Rural Development (MURD)</td>
</tr>
<tr>
<td>Regional Government</td>
<td>Ministry of Agriculture, Water and Land Reform (MAWLR)</td>
</tr>
<tr>
<td></td>
<td>Ministry of Industrialisation, Trade and SME Development</td>
</tr>
<tr>
<td></td>
<td>Ministry of Labour, Industrial Relations and Employment Creation</td>
</tr>
<tr>
<td>Local Government</td>
<td>Kavango West Regional Council</td>
</tr>
<tr>
<td></td>
<td>Kavango East Regional Council</td>
</tr>
<tr>
<td>Traditional / Tribal Authorities</td>
<td>Kwangali, Mbuza, Shambyu, Gciruku and Mbukushu</td>
</tr>
<tr>
<td>Local Communities</td>
<td>Nkurenkuru, Rundu, Sivaradi 1 and 2, Gcaru, Ncuncuni, Ncaute, Makandina, Mutwegombahe, Mbambi and Cuma</td>
</tr>
<tr>
<td>State Owned Enterprises</td>
<td>Roads Authority (RA)</td>
</tr>
<tr>
<td></td>
<td>Namibian Port Authority (NamPort)</td>
</tr>
<tr>
<td></td>
<td>Others to be identified</td>
</tr>
<tr>
<td>Political Parties Representatives (Councillors)</td>
<td>South West Africa People's Organization (SWAPO)</td>
</tr>
<tr>
<td></td>
<td>Official Oppositions Party</td>
</tr>
<tr>
<td>Trade Unions</td>
<td>Other Opposition Parties / Independent representatives</td>
</tr>
<tr>
<td>Non-Profit Organisations and conservation organisations</td>
<td>All as may be applicable to the Project</td>
</tr>
<tr>
<td>Print and Electronic Media Houses</td>
<td>National Non-Governmental Organisations (NGOs) and Community Based Organisations (CBOs)</td>
</tr>
<tr>
<td>Project Contractors and Business Partners</td>
<td>Local Newspapers (New Era, The Namibian, Republikein, Confidente, Windhoek Observer, Allgemeine Zeitung and other local newspapers), TV and radio stations</td>
</tr>
<tr>
<td>General public</td>
<td>Others to be identified</td>
</tr>
<tr>
<td>Other International, Regional and Local Stakeholders</td>
<td>To be identifies as the Project Progress and during stakeholders consultation</td>
</tr>
</tbody>
</table>
2.4.3 Selection of the Appropriate Consultation Method

Variety of engagement techniques were used to share information, gather information from stakeholders, consult with stakeholders, and disseminate project information to stakeholders. Culturally appropriate consultation methods, and the purpose for engaging with a stakeholder group were considered.

The following are the key examples of the consultation methods that were used:

- Prepared formal project specific information dissemination presentations when consulted government (Central, Regional or Local Authority) officials.
- When dealing with communities, targeted meetings with a mixture of the use of posters, handouts leaflets, videos and formal interactive simple physical visual examples that allowed the participants to contribute and participate in the discussion, and.
- When working with an informal focus group discussion this was facilitated by PowerPoint presentations, posters, non-technical pamphlets and other visual materials.

Table 2.3 provides a detailed summary of the engagement methods that were adopted as was applicable to a specific stakeholder group.

Table 2.3: Assessment of potential appropriate engagement method and associated activities.

<table>
<thead>
<tr>
<th>ENGAGEMENT METHOD</th>
<th>MOST APPROPRIATE PUBLIC / STAKEHOLDER ENGAGEMENT ACTIVITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Print media / Newspaper advertisement / notices / Articles</td>
<td>× Published advertisements / notices / articles in local newspapers about the proposed project and consultation activities being undertaken</td>
</tr>
<tr>
<td>Social media</td>
<td>× Facebook, twitter, WhatsApp, and other media platforms were used to inform and distribute information to key stakeholders</td>
</tr>
</tbody>
</table>
| Correspondence by formal letters phone /email/Text/Instant messaging/ Voice or Video Conferencing/ Information Seminars | × Distribute project information to government officials, organisations, agencies and companies  
× Invited stakeholders to meetings |
| Radio announcements | × Disseminate project information to large audiences, and rural stakeholders through the offices of the regional councils, councillors and traditional authorities  
× Inform stakeholders about consultation meetings |
| One-on-one interviews | × Solicit views and opinions  
× Enable stakeholders to speak freely and confidentially about controversial and sensitive issues  
× Build personal relations with stakeholders especially community influencers  
× Recording of interviews |
| Formal / Informal poster / meetings session | × Presented project information to groups of stakeholders  
× Facilitated meetings using PowerPoint presentations, posters, models, videos and pamphlets and project information documents  
× Allowed the group of stakeholders to provide their views and opinions  
× Build impersonal relations with high level stakeholders  
× Distributed technical documents  
× Record discussions, comments/questions raised and responses |
| Public meetings | × Present project information to a large audience of stakeholders, and in particular communities / town halls / open village tree settings  
× Allow the group of stakeholders to provide their views and opinions  
× Build relationships with neighbouring communities  
× Distribute non-technical project information  
× Facilitate meetings using PowerPoint presentations, posters, models, videos and pamphlets or project information documents  
× Record discussions, comments/questions raised and responses |
2.4.4 Stakeholder Engagement Schedule

Stakeholder engagement is important throughout the lifecycle of the proposed project 2D seismic survey operations. In accordance with the provisions of the EIA Regulations, 2012, the following is summary of key phases of the required stakeholders consultations and engagement processes:

(i) Pre-survey scouting to assess accessibility and confirm the line survey scouting to be included in the EIA Process undertaken during the month of December 2020 and January 2021.

(ii) EIA and EMP regulatory permitting process undertaken in January and February 2021.

(iii) Planning and mobilisation (Tracks / roads preparation (narrow tracks widening) to be undertaken before implementation in 2021.

(iv) Data acquisition (Actual Survey) to be undertaken before implementation in 2021, and.

(v) Demobilisation and survey completion to be undertaken before implementation in 2021.

2.4.5 Regulatory Consultation Public and Stakeholder Meetings Schedule

The following public meetings and open days sessions were organised as part of the stakeholder and public consultation process for the proposed 2D seismic survey operations in PEL 73 specifically targeting the regional and local communities of Kavango West and East Regions and an opportunity for a factual field visits for I&APs from outside the two regions:

(i) Kavango West Region, Nkurenkuru, Nkurenkuru Community Hall, Wednesday, 20th January 2021, Morning Session from 10hrs00 to 13hrs00 Formal Meeting and Afternoon Session from 15hrs00 to 18hrs00 Open Sessions Public walk in as needed.

(ii) Kavango East Region, Rundu, AMTA, Friday 22nd January 2021, Morning Session from 10hrs00 to 13hrs00 Formal Meeting and Afternoon Session from 15hrs00 to 18hrs00 Open Sessions Public walk in, and.

(iii) Khomas Region, Windhoek, Hotel Thule, 2nd February 2021, Morning Session from 10hrs00 to 13hrs00 Formal Meeting and Afternoon Session from 14hrs00 to 16hrs00 Formal Meeting, and.

(iv) Field-based public / local villages community meetings and poster sessions at the following key settlements situated along the various seismic survey lines: Sivaradi 1 and 2, Gcaru, Ncuncuni, Ncaute, Makandina, Mutwegombahe, Mbambi and Cuma. The field-based meetings / sessions undertaken in coordination with the regional councillors and traditional authorities from 23rd January 2021 to the 8th February 2021.

Additionally, the prepared environmental reports to be submitted to the Environmental Commissioner will be subjected to further public consultation and disclosure by the Environmental Commissioner for a period of fourteen (14) days. All registered stakeholders will be informed once the environmental reports are available at www.eia.met.gov.na.

2.5 Impact Assessment Process

2.5.1 Overview

The overall impact assessment adopted a framework like the Leopold matrix framework which is one of the internationally best-known matrix assessment methodology available for predicting the impact of a project on the receiving environment. The assessment process took into considerations the proposed activities, trade-offs, alternatives, and issues to be considered as assessed in this EIA report. Further inputs were provided by specialist consultants.
2.5.2 Individual Components Impact Assessment Criteria

Based on the Terms of Reference and overall outcomes of the scoping phase (Annex 1), all key components of the receiving environment were identified and assessed with respect to the proposed 2D seismic survey operations.

2.5.3 Overall Component and Significant Impact Assessment

2.5.3.1 Overall Component Impact Assessment

The overall component impact assessment and evaluation process has been undertaken by considering the activities of the proposed 2D seismic survey operations as the overall source of impact. The receiving environment has been considered as the receptor / target that may be impacted positively or negatively by the activities of the proposed 2D seismic survey operations. The components of the receiving environment encompassed the following:

- Physical Conditions / Natural Environment: Air, noise, water, green space, climate change, built environment houses, roads, transport systems, buildings, infrastructure, etc.
- Biological Conditions: fauna, flora, habitats, and ecosystem - services, function, use values and non-use etc., and.
- Socioeconomic Conditions: Social, economic, labour, gender, human rights, natural and social capital, archaeological, cultural resources, and cultural issues

In evaluating the degree of potential negative impacts, the following factors have been taken into consideration:

- Impact Severity: The severity of an impact is a function of a range of considerations, and.
- Likelihood of Occurrence (Probability): How likely is the impact to occur?

In evaluating the severity of potential negative environmental impacts, the following factors have been taken into consideration:

- Receptor/ Resource Characteristics: The nature, importance, and sensitivity to change of the receptors / target or resources that could be affected.
- Impact Magnitude: The magnitude of the change that is induced.
- Impact Duration: The time period over which the impact is expected to last.
- Impact Extent: The geographical extent of the induced change, and.
- Regulations, Standards and Guidelines: The status of the impact in relation to regulations (eg. discharge limits), standards (eg. environmental quality criteria) and guidelines.

The overall impact severity has been categorised using a subjective scale as shown in Table 2.4 for magnitude, Table 2.5 for duration and Table 2.6 for extent.

Table 2.4: Scored on a scale from 0 to 5 for impact magnitude.

<table>
<thead>
<tr>
<th>SCALE (-) or (+)</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>no observable effect</td>
</tr>
<tr>
<td>1</td>
<td>low effect</td>
</tr>
<tr>
<td>2</td>
<td>tolerable effect</td>
</tr>
<tr>
<td>3</td>
<td>medium high effect</td>
</tr>
<tr>
<td>4</td>
<td>high effect</td>
</tr>
<tr>
<td>5</td>
<td>very high effect (devastation)</td>
</tr>
</tbody>
</table>
Table 2.5: Scored time over which the impact is expected to last.

<table>
<thead>
<tr>
<th>SCALE (-) or (+)</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>Temporary</td>
</tr>
<tr>
<td>P</td>
<td>Permanent</td>
</tr>
</tbody>
</table>

Table 2.6: Scored geographical extent of the induced change.

<table>
<thead>
<tr>
<th>SCALE (-) or (+)</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>limited impact on location</td>
</tr>
<tr>
<td>O</td>
<td>impact of importance for municipality.</td>
</tr>
<tr>
<td>R</td>
<td>impact of regional character</td>
</tr>
<tr>
<td>N</td>
<td>impact of national character</td>
</tr>
<tr>
<td>M</td>
<td>impact of cross-border character</td>
</tr>
</tbody>
</table>

The likelihood (probability) of the pre-identified events occurring has been ascribed using a qualitative scale of probability categories (in increasing order of likelihood) as shown in Table 2.7. Likelihood is estimated on the basis of experience and/ or evidence that such an outcome has previously occurred. Impacts resulting from routine/planned events are classified under category (E).

Table 2.7: Summary of the qualitative scale of probability categories (in increasing order of likelihood).

<table>
<thead>
<tr>
<th>SCALE (-) or (+)</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Extremely unlikely (e.g. never heard of in the industry)</td>
</tr>
<tr>
<td>B</td>
<td>Unlikely (e.g. heard of in the industry but considered unlikely)</td>
</tr>
<tr>
<td>C</td>
<td>Low likelihood (e.g. such incidents/impacts have occurred but are uncommon)</td>
</tr>
<tr>
<td>D</td>
<td>Medium likelihood (e.g. such incidents/impacts occur several times per year within the industry)</td>
</tr>
<tr>
<td>E</td>
<td>High likelihood (e.g. such incidents/impacts occur several times per year at each location where such works are undertaken)</td>
</tr>
</tbody>
</table>

The overall individual components impact assessment with respect to the impact duration, geographical extent and probability of occurrence have been categorised using a semi quantitative approach as shown in Table 2.8 and the results are presented in this report under Chapter 6.

2.5.3.2 Overall Significant Impact Assessment

The determination of the significance of the negative impacts / key issues caused by the proposed 2D seismic survey activities as key sources of such impact has been based on the environmental baseline results and the intensity of the likely negative impact as assessed under individual components likely to be impacted (Table 2.8).

The assessment focused on the degree to which the proposed project activities are likely to results in unwanted consequences on the receptor covering the receiving environment (natural, built, socioeconomic, flora, fauna, habitat, and ecosystem).

The overall significant impact assessment of the individual components assessed are presented in Table 2.9 with the results provided in this report under Chapter 6.
Table 2.8: Impact assessment matrix used for assessing the overall likely impacts that the proposed 2D seismic survey activities will have on the individual components of the receiving environment sensitivity (physical, biological, socioeconomic, cultural, and archaeological environments) with respect to duration, geographical extent, and probability occurrence.

<table>
<thead>
<tr>
<th>RECEIVING ENVIRONMENT SENSITIVITY</th>
<th>PHYSICAL ENVIRONMENT</th>
<th>BIOLOGICAL ENVIRONMENT</th>
<th>SOCIOECONOMIC, CULTURAL, AND ARCHAEOLOGICAL ENVIRONMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Water Quality</td>
<td>Physical Infrastructure and Resources</td>
<td>Protected Areas</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Air Quality, Noise and Dust</td>
<td>Habitat</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Landscape Topography</td>
<td>Soil Quality</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Soil Quality</td>
<td>Climate Change Influences</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**RECEIVING ENVIRONMENT SENSITIVITY**
- **1. Negligible**: The receptor or resource is resistant to change or is of little environmental value.
- **2. Low**: The receptor or resource is tolerant of change without detriment to its character, is of low environmental or social value, or is of local importance.
- **3. Medium**: The receptor or resource has low capacity to absorb change without fundamentally altering its present character, is of high environmental or social value, or is of national importance.
- **4. High**: The receptor or resource has moderate capacity to absorb change without significantly altering its present character, has some environmental or social value, or is of district/regional importance.
- **5. Very High**: The receptor or resource has little or no capacity to absorb change without fundamentally altering its present character, is of very high environmental or social value, or is of international importance.

**SOURCES OF POTENTIAL IMPACT**

**ROUTINE AND PHYSICAL PRESENCE OPERATIONAL ACTIVITIES**
1. Planning and mobilisation (Pre-survey preparation)
   - Camp sites setups and widening of tracks and creation of limited new access as may be applicable
2. Actual data acquisition along the individual profiles / survey lines
3. Demobilisation and Closure (Survey Completion)

**UNPLANNED ACCIDENTAL EVENTS**
4. Any accidental event that may be associated with the routine and physical presence operational activities
Table 2.9: Assessment matrix used for assessing the likely overall significant impacts with respect to proposed 2D seismic survey activities on the receiving environment (physical, biological, socioeconomic, cultural, and archaeological environments).

<table>
<thead>
<tr>
<th>IMPACT SEVERITY</th>
<th>RECEPTOR CHARACTERISTICS (SENSITIVITY)</th>
<th>PHYSICAL ENVIRONMENT</th>
<th>BIOLOGICAL ENVIRONMENT</th>
<th>SOCIOECONOMIC, CULTURAL, AND ARCHAEOLOGICAL ENVIRONMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Very High (5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>High(4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Medium (3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Low (2)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Negligible (1)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Magnitude, Duration, Extent, Probability</th>
<th>Water Quality</th>
<th>Physical Infrastructure and Resources</th>
<th>Air Quality, Noise and Dust</th>
<th>Landscape Topography</th>
<th>Soil Quality</th>
<th>Climate Change Influences</th>
<th>Habitat</th>
<th>Protected Areas</th>
<th>Flora</th>
<th>Fauna</th>
<th>Ecosystem functions, services, use values and non-use or passive use</th>
<th>Local, regional, and national socioeconomic settings</th>
<th>Subsistence Agriculture</th>
<th>Community Forestry</th>
<th>Tourism and Recreation</th>
<th>Cultural, Biological and Archaeological Resources</th>
</tr>
</thead>
</table>

**Sources of Potential Impact**

1. Planning and mobilisation (Pre-survey preparation)
2. Camp sites setups and widening of tracks and creation of limited new access as may be applicable
3. Actual data acquisition along the individual profiles / survey lines
4. Demobilisation and Closure (Survey Completion)
5. Any accidental event that may be associated with the routine and physical presence operational activities
2.6 Mitigation Measures for Significance Impacts

2.6.1 Overview

Based on the finding of this EIA Report, an EMP Report has been prepared detailing the mitigation measures that the Proponent shall implement in minimising and maximising the likely effects of negative and positive impacts respectively.

2.6.2 Mitigation Measures Guiding Principles

The following is the summary of the guiding principles with respect to the mitigation measures as presented in the EMP Report in order of preference and in addressing the impacts assessed to have likely significant adverse effects on the receiving environment:

(i) Enhancement, e.g. provision of new habitats or supporting infrastructure such as access for the local community.

(ii) Avoidance, e.g. sensitive design to avoid effects on ecological receptors.

(iii) Reduction, e.g. limitation of effects on receptors through design changes, and.

(iv) Compensation, e.g. community benefits.

2.6.3 Monitoring and Reporting Guiding Principles

The environmental performance monitoring process to be provided for in EMP shall be undertaken by the Proponent and shall include the preparation of the environmental monitoring reports and reporting thereof, as may be required by the various permits, certificates, consents, or authorisations as granted by the Government.
3. PROPOSED PROJECT DESCRIPTION

3.1 Origin of Petroleum and Petroleum Exploration

Petroleum (oil and gas) is formed from the remains of ancient marine organisms, such as plants, algae, and bacteria in geological environments called Sedimentary Basins (Fig. 3.1). A Sedimentary Basin is a region of the Earth where long-term depressional setting has allowed for the accumulation of thick layers of sediments with remains of ancient marine organisms. As the sediments continue building-up and are buried deeper within a Sedimentary Basin, the various bottom layers that were initially deposited, will be subjected to increasing pressure and temperature because for every 1km that one goes deeper into the earth’s crust, the temperature on average increases by 25°C. The increase of temperature and pressure as a result of the weight of the overlaying materials, initiates the process of cooking. If the sedimentary rock has enough organic materials for generating oil and gas and if the subsurface conditions are favourable, oil or gas may be generated within the temperature window range of between 100°C - 120°C and equivalent to the depths of more than 4km. The oil or gas that get deposited within the Sedimentary basin, again if the conditions and geological structures favours its accumulation, will remain trapped until discovered or until the natural conditions within the basin changes and forces the oil or gas to leak or vaporise. Such changes in Sedimentary basin conditions may be as a result of increasing temperature within the basins cooks the oil or gas forces it to vaporise or could also be the opening of the trap that allows the oil or gas to escape and leak out.

In simple terms a license area for oil and gas and a sedimentary basin are like a plot with a built modern family home comprising bedrooms, kitchen and dining and other rooms. A house, if built, often occupies a fraction of any given plot and is correspondingly to a Sedimentary Basin if present within a license area and only occupies a fraction of any given license. In oil and gas terms, the key areas of interest for the entire house (Sedimentary Basin) are the kitchen and dining room equated to a source and reservoir rocks respectively. Within a house environment, food is cooked in the kitchen and eaten in the dining room. Oil is formed in source rock (kitchen) and then it migrates and accumulates in a reservoir (dining room) which is often the key target area for any oil and gas exploration operations. A reservoir is similar to a dining room for anyone hoping to have a good meal, especially after noticing cooked food remains in the kitchen. However, even after noticing cooked food remains in the kitchen (sources rock), there is no guarantee that the food will still be in dining room because may be someone was already in dining room and has eaten all or much of the food and this is similar to the situation where oil or gas is formed and signs of it are detected in the source rock (kitchen) and a reservoir is found but it is empty or has some oil or gas but not economic.

The sedimentary rocks capable of generating oil or gas when subjected to high pressures and temperature are called source rocks e.g. limestone or shale. Once oil and gas resources are formed, they are flushed out of the source rock due the high pressure created by the weight of the overlaying materials. Oil and / or gas often migrates to suitable area where accumulation takes places in rocks called oil or gas reservoirs. A petroleum reservoir or oil and gas reservoir is a porous or fractured subsurface rock mass saturated with hydrocarbons and can be a sandstone, shale, limestone or salt dome. Pores space and permeability are key important rock properties in oil and gas exploration. Pore space being the void space in the rocks, while permeability defines the connection of the pore spaces (pores) to each other which then allows fluids to flow in a rock. Most shales have very low permeability, but relatively good porosity is reason for fracking to allow oil or gas to flow to hole if discovered in a shale rock.

Petroleum reservoirs are broadly classified as conventional (with natural pores and permeability) and unconventional (natural pores but limited permeability). It is important to know that fracking only comes into play after the discovery of economic vast oil or gas reserves found in a reservoir with natural storage (pores) but limited storage connectivity (permeability) abilities. At present Namibia does not have any onshore oil or gas discovery and yet alone in a reservoir with limited connectivity abilities and requiring fracking to produce or pump it.
How Petroleum and Natural Gas Were Formed

Tiny sea plants and animals died and were buried on the ocean floor. Over time, they were covered by layers of sediment and rock.

Over millions of years, the remains were buried deeper and deeper. The enormous heat and pressure turned them into oil and gas.

Today, we drill down through the layers of sedimentary rock to reach the rock formations that contain oil and gas deposits.

Figure 3.1: Illustration of how oil and gas are formed over millions of years (Source: https://letslearngeology.wordpress.com/oil-formation-petroleo/).
### 3.2 Understanding Petroleum (Oil and Gas) Exploration

Oil and gas exploration is indeed an expensive journey with uncertain known destination and if one is to compare it to say a journey from Windhoek to Rundu, ReconAfrica has left Windhoek but has not yet even arrived in Okahandja and that is the reality. However, to fund the journey to the intended destination which is Rundu, ReconAfrica or any other resources exploration company must market a vision about the destination even though there are no guarantees that the destination will be indeed Rundu which could be equated to a commercial discovery at the end of an exploration / prospecting programme aimed at validating a developed theoretical oil or gas model.

When developing a theoretical model for oil or gas exploration, all the boundary conditions including the conventional and conventional options are usually included in the sub models' assumptions and the objective of implementing the exploration programme is to de-risk the model by validating and testing the key input variables which were initially assumed for the knowledge-base and boundary conditions. Unfortunately, those with no knowledge of how this complicated and highly technical oil and gas exploration business operates, often tend to rush into populating the knowledge-base and drawing-up boundary conditions of the theoretical hydrocarbon model that they do not even know or understand.

Oil and gas exploration process starts with the implementation of developed theoretical hydrocarbon model over the entire licensed area to identify potential key targets of interest in form of a Sedimentary Basin with potential to host source rocks and reservoir structures with theoretically assumed boundary condition that support the occurrence of economic oil and gas reserves. The following is a summary of general exploration de-risking activities that are implemented in validating the developed theoretical hydrocarbon model including boundary conditions for identifying site-specific localities with potential for holding economic oil and gas resources or uneconomic resources or nothing because exploration does not guarantee discovery and those undertaking and financing / investing in oil and gas exploration know very well the high stakes and rewards involved in this business:

1. **Regional and local desktop study:** This is the assessment of all existing data sets such as the geology, environment, hydrogeology, aerial, and ground geophysics (Gravity, Magnetics and Seismic), historical wells drilled in the region and general area. This data is normally purchased from the Government and in Namibia, Namcor sales this data in USD. The overall objective is to build a prospectivity sub model of the licensed area by identifying potential targets or initial leads within the license area. This step covers the whole licensed area and with limited to no fieldwork undertaken.

2. **Based on the desktop studies above, usually detailed assessment of any existing geophysical data such as ground or aerial gravity, magnetics or ground seismic is undertaken, although gravity data is one of the key primary data sets. Gravity data is used to identify key areas of interest having thick sediment deposit or build-up (Sedimentary Basins) and such as areas are often coloured blue on gravity map.**

3. **Magnetic data will often be used to identify geological bodies that may have intruded the potential thick sediment areas (Sedimentary Basins) and if oil and gas was there at the time of the intrusion occurring, then the geological body may have cooked it and forced it to vaporise and disappear. Therefore, high magnetic zones will be no-go zones or not prospective for oil or gas exploration activities.**

4. **To understand if the identified sedimentary areas without potential magnetic geological bodies have potential geological structural traps called reservoirs that can store oil or gas, ground seismic survey is usually undertaken, followed by drilling of an exploration well/s to test and see if the seismic identified geological traps or reservoirs indeed exist and contain oil or gas and this EIA focuses specifically at this stage of the exploration process (2D seismic survey). However, in some instances the existing geological information can be insufficient to be able to plan and design an exploration well. In order to de-risk the exploration operations especially in a situation where the presence of a sedimentary basin**
is unknow, Stratigraphic Test Wells are sometimes drilled, similar to the two (2) to three (3) wells that ReconAfrica is proposing to drilled. A Stratigraphic Test Well is any well or hole, drilled for the purpose of gathering geological information (logging) in connection with the oil and gas exploration opportunities with no intent to produce oil or gas from such well.

5. If Stratigraphic Test Well drilling operations confirm the presence of a sedimentary basin, 2D or 3D Ground Seismic Surveys are often undertaken before any detailed exploration well/s drilling operation is implemented. Seismic survey works like an Ultrasound imaging also called ultrasound scanning or sonography using sound to generate images of the human body. Seismic surveys use an energy source to generate sound waves used in the imaging of the earth’s subsurface in search for potential reservoir structures. These structures will thus be potential targets for exploration well/s drilling operations if the key boundary conditions are favourable.

6. Following the acquisition and processing of the 2D or (3D) seismic data and the delineation of potential geological structures, the drilling of exploration wells follows. An exploration well is drilled to find out if there is any oil or gas at a given locality. Exploration wells are drilled purely for exploratory and information gathering purposes and not for oil or gas production. Several exploration wells have been drilled in both the onshore and offshore environments of Namibia.

7. Once an exploration well has discovered oil and gas, the next step in the exploration process is to determine the economics of the find and the de-risking process cover the drilling of multiple appraisal testing wells in order to define the size of oil or gas field discovered. The overall aim is to assess the characteristics of the reservoir and determine if the discovered oil or gas can be produced economically using either conventional and unconventional production methods. However, the discovery of oil or gas does not guarantee a commercial discovery production and a good example is the Kudu Field discovered in 1974 by Chevron Texaco, offshore southern Namibia. The Kudu Gas is situated about 170 kilometres northwest of Oranjemund and in water depth of about 170m. Since its discovery, the field has been owned by several major global oil and gas exploration and production companies and despite being under a Production License, to date no development model has proved favourable to produce the gas from this field. Various production options such as the liquefying of the gas for export to Europe and building of a 170 km long pipeline to a power station that could have been built at Uubvlei, approximately 25 km north of Oranjemund in southern part of Namibia to generate clean electricity, have all failed the economic test, and.

8. The economic evaluation is very a complex process and will consider issues related to how the oil and gas could be produced safely and economically. Subject to the type and characteristics of the oil or gas discovered, considerations for the development of key supporting infrastructure such as a pipeline, a refinery or a power station option will be evaluated with linkages to the technological requirements, national environmental, security, financial and all other applicable national regulations and international standards for oil and gas production.

A holder of Exploration License can apply for a Production License through the MME with a new EIA being done in order to obtain a new ECC for conventional or unconventional oil or gas production operations.

Once all permits have been obtained, the development of the oil or gas field can then start and it takes years before a field can start to produce oil or gas and the country can start getting long-term tangible benefits from the production and direct or indirect sale of oil and gas produced. Usually, economic benefits from commercial oil and gas discovery starts earlier before the gas or oil field even start to produce.

During the development process massive capital inflow comes into the country and an array of employment opportunities are often created associated with field development activities and all the supporting infrastructure development process.
3.3 Proposed 2D Ground Seismic Survey as an Exploration Method

3.3.1 Basic Principles of 2D Ground Seismic Survey

Ground seismic survey method are among the proven technologies that are used in the search for earth resources. The results from the 2D ground seismic survey operations will assist in delineating potential target areas suitable for drilling of exploration wells. Land seismic data acquisition uses primarily two types of seismic energy sources, non-impulsive Vibroseis trucks and Explorer 860 or an impulsive energy source such as a low-impact charge that generate acoustic waves which propagate deep into the earth. During the seismic survey, the generated seismic wave which travels into the earth, reflected by subsurface formations, and returns to the surface where it is recorded by receivers called geophones which are like microphones (Fig. 3.2). The resultant product is a vertical sonic cross-section of the subsurface beneath the survey line showing the geological materials (de-risked geological sub model) and structures that the acoustic wave has travelled through (Fig. 2.3). This information is used to predict where oil or gas may be trapped in sufficient quantities for exploration activities.

![Explorer 860](image)

**Figure 3.2:** Illustration of the 2D ground seismic survey operation to be undertaken in PEL No. 73 along the proposed lines using the Explorer 860 as the energy sources with wireless receivers (Photos Source: [http://www.polarisexplorer.com](http://www.polarisexplorer.com)).

3.3.2 Vibroseis, Dynamite or Explorer 860 Seismic Operations

3.3.2.1 The Use of Dynamite as an Energy Source

Since the beginning of seismic exploration, dynamite has been the universally acceptable source for generating seismic energy because it produces great quantities of energy. It is not expensive as vibroseis and it is equally safe to use only when handle correctly by experts. It can be used in both land and marine work in most climate and field conditions. Characteristic of seismic dynamite explosive developed for seismic work use nitroglycerin and / or nitrocellulose as active ingredients. This substance in its pure state is extremely dangerous and highly volatile. However, when these highly explosive substances are absorbed by a pores material such as wood pulp, kieselguhr, powdered chalk, or roasted flour they are quite safe to transport, to store and use (Monk et al., 2004).

The cost of drilling holes for a dynamite-based seismic survey can become a critical factor in the overall design of the survey. This effectively places a limit on the shot line interval, and the shot interval down
a line (Monk et al., 2004). When using the surface weight drop system, shots can be taken very rapidly, and with more than one unit active it is possible to achieve levels of shot production which are likely to be much higher than achievable with dynamite. In this case the limiting factor to operational efficiency moves away from the shots, and recording is limited by the number of receivers that have to be moved on a regular basis. If receiver limits the operation moves, then the number of shots can be increased (with surface weight drop) without any increase in cost of operations. It is therefore possible to increase the effective fold of 2D seismic using surface weight drop systems by decreasing the shot interval along the shot line without detriment to the efficiency of crew, or cost of operation. This further has the potential to improve the quality of the final seismic data. The following are the key characteristics advantages and disadvantages of using dynamite as an energy source:

- Dynamite is a good energy but once it is gone it is gone since it is not renewable, and.

- One advantage of dynamite is the high-power source of short duration as such, it creates a compact wavelet with a wide bandwidth. Another advantage a dynamite has over vibroseis trucks are its light weight, low-cost lack of required maintenance and capacity for deployment in rugged terrain unreachable by vehicles (Oriard, 1994). However, the process of drilling shot holes, burying the dynamite, and cleaning up after the operation is labour intensive, and with this option the survey geometry cannot be changed without drilling new shot holes. Hence, input signal can be neither measured nor reliably repeated. Also, dynamite explosive sources are subject to strict security regulations and permission for use and transportation may be difficult to obtain in some places. They carry a greater potential for causing damage hence their prevention in usage in populated areas (Oriard, 2002).

3.3.2.2 The Use of Vibroseis as an Energy Source

The vibroseis method was developed in the USA to allow seismic to be acquired in cities and other sensitive environments, eliminating the need for dynamite to generate the much-needed seismic signal, instead, generating a controlled vibration that will not damage structures in close proximity to the produce signal source (Teasdale et al., 2006). The following are the key characteristics advantages and disadvantages of using Vibroseis as an energy source:

- Vibroseis has a greater advantage in energy spectrum control as this can be done with much ease than in the use of dynamite. The force applied to the ground can be monitored and adjusted in real time. Hence the effective usage of vibroseis in urban areas. However, vibroseis have great restriction of access in difficult terrains like swamps, mountains and coastal areas (Oriard, 1999).

- One of the most important characteristics of Vibroseis method is the limitation of the bandwidth of the source. By this way, vibroseis technique allows one to generate only those frequencies which are needed whereas with the case of dynamite, some of the frequencies generated by the blast are ignored during the seismic acquisition, and.

- Explosive source develops its power in a very short time whereas vibrational sources distribute their power for a sustained period usually several seconds.

3.3.2.3 The Use of the Explorer 860 as an Energy Source

The new source Explorer 860 (Plate 3.1) has the capability of generating a very large surface impact, with a high degree of repeatability, but it also controllable so that the impact effort can be reduced if required. This control has help to minimized ground roll generation and improved the resultant seismic data. The only difference is that instead of hitting the ground with the plate a special aluminium alloy steel is put on the ground and transfers energy to the ground. All the weight is put on the plate and energy is transferred to a recorder. The hammer comes down on the plate leaving next to no imprint on the ground. The impact on the steel, steel on steel and energy is transferred. This method has significantly replaced the dynamite because energy is renewable in this form than in the dynamite system. The following are the key characteristics advantages and disadvantages of using the Explorer 860 as an energy source:
The Explorer 860 is the world fastest, strongest and most accurate accelerated weight drop seismic energy source. It is environmentally friendly and has worked in urban and protected areas with virtually zero ground disturbance.

Unlike conventional weight drop system, the Explorer 860 is also highly controllable. The system uses hydraulics to raise and lower the weight, and plumbed into the top of the hydraulic cylinder is a nitrogen gas charged accumulator. Pressure in the accumulator can be adjusted, and this pressure controls the force acting on the top of the weight when it is released.

- Has up to 860,000 lbs of peak force.
- Faster than the vibroseis.
- Has very high fold.
- Has better quality than dynamite.
- Is perfect for high density population and environmental sensitive areas.
- Has only single unit required per second source point, and.
- One disadvantage of Explorer 860 is its capital deployment to site of interest and maintenance.

Plate 3.1: Size comparative of the Vibroseis truck (top) and Explorer 860 Accelerated Weight Drop (AWD) (bottom) (Sources: www.polarisexplorer.com).
3.3.3 Proposed 2D Seismic Survey Design, Layout and Implementation

3.3.3.1 Proposed Survey Design and Layout

The location of the proposed 2D seismic survey lines numbered NS1-NS5 and EW1-EW5 are shown in Fig. 1.4. The proposed survey lines will follow existing roads and tracks as shown in Figs. 1.4 and 1.5 and Plates 1.1 -1.32. The technical design and layout of the proposed 2D seismic survey covers the following key considerations:

(i) North-south and east west oriented lines have been designed with line layout cutting across the key areas of interest as shown in Fig. 1.4.

(ii) All the lines have been designed to follow existing roads or tracks that have been verified to exist as shown in Fig. 1.5.

(iii) All the roads and tracks along which the survey will be conducted have been verified to exist as shown in drone views in Plates 1.1 -1.32.

3.3.3.2 Proposed 2D Ground Survey Implementation Stages

The implementation of the proposed 2D ground survey programme can be divided into three (3) stages and each stage will be evaluated in detailed during the EIA stage. The following is the summary of the four (4) stages:

(i) Pre-survey scouting in order to assess accessibility and confirm the line survey scouting to be included in the EIA Process.

(ii) Planning and mobilisation (Tracks / roads preparation (Clearing and widening).

(iii) Data acquisition (Actual Survey), and.

(iv) Demobilisation and survey completion.

The Survey Team will mobilise and will consist of one (1) Survey Coordinator, one (1) Survey Processor/Mapper, 2 National field mappers and 6 National survey rovers. Survey teams will be expected to survey between 150-250 points per day with a total daily production of 1600 source points per day = 95 km per day. Each Survey Rover will have two (2) local helpers - who will be trained in survey techniques.

The Survey Team will immediately set up a control network and once established will begin surveying. Line surveying will be conducted utilising Trimble R8 RTK GPS receivers. The Survey Coordinator, along with the Project Manager and Security Manager will have a daily plan for the Survey Team. Daily production for each team will be 3-4 km5 per day.

Positions will be marked with which marker is most effective and least likely to be disturbed by the local villagers. These could be pin flags, lathe, shipping tags, ribbon or painted rocks.

A dedicated Survey Processor will be on site throughout the duration of the project to manage Survey data; update and organize information passed along; and maintain a hazard map for quick reference by all crews to understand recognized hazards. The Survey Processor will be responsible for delivering survey data to the onsite quality control Geophysicist whose responsibility will be to deliver script files to the Observer for recording.

All positional surveying work will be carried out to a good professional standard and all personnel engaged in geodetic, surveying, positioning, and setting out work will be appropriately qualified and experienced and be fully aware of the objectives, methods to be employed and accuracy required.

Modern survey equipment and techniques will be employed. Survey control will be Established using no less than 4-hour static survey preferably with 2 other baselines running concurrent or Bases
checked with 180 epoch RTK shot. All static survey control will be processed with the Canadian Government Internationally accepted processing utility. Check shots for each roving GPS pack will be made at the start and end of every day and checked in database.

Co-ordinates will be based on the geodetic framework as specified by ReconAfrica. Survey observations of all control and line points will contain redundancy for checking purposes and be observed and recorded in such a way as to allow independent verification of plan and height values.

All surveying methods will be checked, all equipment calibrated and results of software in use verified to the satisfaction of ReconAfrica prior to commencement.

Lateral offsets will be indicated on all documents (topographic reports, line logs, etc.). In the presence of obstacles, culture or cultivated areas, with prior ReconAfrica Representative agreement, the obstacle will be either laterally offset or undershot, according to the size of the obstruction.

When determining source locations, the contractor will observe ReconAfrica and local procedures and/or regulations governing minimum shooting distances from structures such as buildings, roads, pipelines, etc. Peak Particle Velocity (PPV) measurements will be made by the contractor at the start and during the seismic survey to confirm the above.

Go-arounds will be marked by the surveying teams in the field and annotated on the line logs. Mapping ahead of the survey crew to identify hazards, obstacles and culture will be done to ensure safety, create a hazard map and virtually remodel line and shot point locations.

Pre-plot co-ordinates for source points (VPs/SPs) and receiver points (RPs) will be generated by the contractor and submitted to ReconAfrica for approval prior to start-up.

### 3.3.4 Description of Proposed Data Acquisition Process

The data acquisition process for the proposed 2D seismic survey operations will be undertaken as illustrated in Fig. 3.2. The proposed 2D seismic survey will be undertaken using two (2) to three (3) Explorer 860 Accelerated Weight Drop (AWD) energy source instead of Vibriosis trucks or dynamite. The Explorer 860 AWD provides unrivalled force and production. Polaris Seismic’s patented Explorer 860 uses servo-valve and mass Low Vibration Track (LVT) technology to produce the most powerful, repeatable, and productive surface energy source in the World. Table 3.1 shows the parameters design options for the proposed 2D seismic survey in PEL 73.

Key specifications of the Explorer 860 to be used as the energy source for proposed 2D seismic survey operations in PEL 73 are shown in Fig. 2.3.

#### Table 3.1: Proposed 2D seismic survey parameters design options.

<table>
<thead>
<tr>
<th></th>
<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Active Channels</strong></td>
<td>800</td>
<td>800</td>
<td>1000</td>
</tr>
<tr>
<td><strong>Source Interval</strong></td>
<td>20m</td>
<td>20</td>
<td>40</td>
</tr>
<tr>
<td><strong>Total Source Points</strong></td>
<td>17,500</td>
<td>17,500</td>
<td>8,750</td>
</tr>
<tr>
<td><strong>Receiver Interval</strong></td>
<td>20m</td>
<td>20m</td>
<td>20m</td>
</tr>
<tr>
<td><strong>Number of Receivers</strong></td>
<td>17,500</td>
<td>17,500</td>
<td>17,500</td>
</tr>
<tr>
<td><strong>Geophone</strong></td>
<td>Node</td>
<td>Node</td>
<td>Node</td>
</tr>
<tr>
<td><strong>Geometry</strong></td>
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<td>7990-10-X-10-7990</td>
<td>9990-10-X-10-9990</td>
</tr>
<tr>
<td><strong>Number of Lines</strong></td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td><strong>Record Length</strong></td>
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<tr>
<td><strong>Total Kilometers</strong></td>
<td>350-450</td>
<td>350-450</td>
<td>350-450</td>
</tr>
</tbody>
</table>
Figure 3.3: Specifications of the Explorer 860 to be used as the energy source for proposed 2D seismic survey operations in PEL 73 (Source: www.polarisexplorer.com).
3.3.5 Recording / Geophones

Energy source points and receiver points will be placed along each of the survey lines targeted to be surveyed. The receiver points whose main purposes will be to record the reflected vibrations from Vibroseis. The spacing of the source and receiver points is determined by the design and objectives of the survey and for the proposed 2D survey. Wireless geophones / receivers / recorders will be used in the proposed survey (Plate 3.2).

The proposed survey will use the STRYDE recording technology which represents the latest, smallest, and most easily deployed system on the market with the following specifications (Plate 3.2):

- 28 days recording at -40 C with 24 hours recording.
- Global Navigation Satellite System (GNSS) enabled with precision timing and self-location capability.
- Compact with a weight of 150 gm and dimensions: 129 x 41 mm.
- One person can carry 90 nodes.
- Rapid turn-around with a 4-hour concurrent data download and charging.
- A 20ft container allows re-charge and download of ~20,000 nodes per day.
- Rugged Sealed Construction and No connector points, and.
- Inductive charging, optical data transfer with a Sealed casing.

Deployment with the STRYDE system is very fast. The proposed acquisition plan includes:

- 2,000 nodes available (or more as may be required for higher density options).
- Three (3) Layout crews with 3 men per crew.
- Two (2) Pick-up crews with 2 men per crew.
- Layout of 1000+ Nodes per day.
- Pick-up of 1000+ Nodes per day, and.
- Concurrent harvesting and charging of 900 Nodes per day.
Plate 3.2: The STRYDE wireless recording instrumentation is the latest technology to be used for the proposed 2D seismic survey operations.

3.3.6 Data Processing and Interpretation

A Seismic Quality Control Field Processor and required onsite data processing will be onsite for the entire duration of the proposed 2D seismic survey operations (Plate 3.3). Field Processing will be completed daily with the requested processing flows outlined in the Scope of Work. Processing software includes the current Vista Field Pro software system. All supporting equipment and services will be available including plotters, monitors, etc. STRYDE systems do not process data but output raw gathers / receiver data subject to 125hz high cut filter. Very-small-aperture terminal (VSAT) communications will allow transmission of data to processing centres as required by ReconAfrica.

The data recorded from the seismic survey will be raw or in unprocessed form. Before it can be used, it must go through a series of computerised processes. These processes such as filtering, stacking, migrating and other computer analysis, make the data useable and require powerful computers and sophisticated computer programs. As computers have become more powerful and processing techniques more sophisticated, it has become common to re-process seismic data acquired in earlier years, creating new opportunities for exploration that could not originally be derived from the 2D data. Processing of data can be very expensive and time-consuming, depending on the size of the area surveyed and the amount of data acquire.
Final resulting processed data will be interpreted by the geophysicist or geologist. The collected seismic data will be interpreted and no two experts will interpret data identically. Geology is still a subjective science. Although dry holes have been greatly reduced by seismic technology, they have not been eliminated. The proper interpretation of seismic survey data is a critical step in the process of selecting a suitable location for drilling of an exploration oil and gas well.

Plate 3.3: Example of the containerised field-based data processing facility and supporting services that will be available for the entire duration of the proposed 2D seismic survey operations (Source: www.polarisexplorer.com).

3.4 Logistics and Resources

3.4.1 Overview

The proposed 2D seismic survey is likely to be completed within three (3) months from the date of implementation. The exploration team will comprise a number of specialists such geophysicists, geologists, surveyors, engineers as well as other supporting crew members such as exploration camp management, vehicles maintenance as well as catering teams. It is estimated that a total of up to forty (40) persons are likely to be involved in the proposed 2D ground seismic survey data acquisition process.

3.4.2 Campsite

A temporary survey campsite will be created within each survey block area. The temporary camp sites will be setup at suitable locations within the survey area and at strategic line intersections. The size of the exploration camp will be of very limited footprints and will be in form of containerised self-contained cabins. The following are some of the key considerations that shall be considered when selecting camp site areas:

- The creation of a camp site shall be undertaken with the permission of the traditional authority and the local headmen and owner of the land.
- The camp site shall not be created too close to the local settlements in order not to have too much interaction with the local community.
- No big trees shall cut around the selected camp areas.
- The camp sites shall be selected in abandoned previous cleared fields in order not to disturbed pristine areas.
× The camp site shall be equipment with all the facilities and services including water supply and chemical toilets.

3.4.3 Lines Widening / Clearing

The proposed survey will be undertaken along the already existing roads and tracks. A typical survey track will need a space opening along the survey line (track) of about three meters (3 m) wide. Wherever possible line clearance will take advantage of existing access that will allow close placement of receivers and source points to the pre-plot designated locations. Following ReconAfrica’s guidelines for offsetting source points priority will be to minimise bush cutting and offset points to clear locations. In the case of Receiver points also meander the line to positions that require minimal line clearing. Layout crews will be equipped with pangas if line clearing is needed. This is a benefit for all stakeholders as it will lessen the impact and damage to the receiving environment. However, if requested by the local community / stakeholders to clear and widen any given track that will be used for the proposed 2D seismic survey operations, this will be undertaken within the framework of Corporate Social Responsibility (CSR) of the Proponent. Supervision of line clearance equipment operators will be managed by the Survey Coordinator and assisted by a Surveyor experienced in the operation of GPS/ LIS (Low Impact Seismic) methodology.

3.5 Vibration, Noise and Dust

3.5.1 Variations

Sylvanus, (2021), provided specialist inputs and assessment of the vibration, noise, and dust with respect to this EIA report. Ground motion caused by the vibration from seismic survey is generally barely perceivable. The further away you are from the vibrating source, the less you would feel the vibration (Teasdale et al, 2006). According to Teasdale et al, (2006), common household activities such as hammering a nail into a wall would cause more vibration to a house than a typical larger vibroseis truck operating in the area.

3.5.2 Noise and Dust

The following are possible sources of air and dust pollution that have been evaluated in this EIA Report with mitigation measures provided in the EMP Report:

(i) Sources of noise and air quality influences;
   × Increased vehicle activities during survey operations along the gravel and tracks, and.
   × Campsite activities including burning of fuels by vehicles and generators.

3.6 Sustainability, Health, Safety, Environment and Social Governance

3.6.1 Overview

The Proponent is committed to responsible operations through Corporate Social Responsibility (CSR) Guiding Principles, commitment to tracking and reporting on Environmental, Social and Governance indicators linked to the various Corporate policies. Detailed information on the sustainability, health, safety, environment, and social governance of the Proponent can be found at [https://reconafrica.com](https://reconafrica.com).

3.6.2 Environmental, Health and Safety Commitments

The Proponent is committed to the protection of all matters related to Environmental, Health and Safety (EHS) of all the employees, contractors, customers, and the public-at-large with respect to the ongoing and upcoming operational activities. During the proposed 2D seismic survey operations, the Proponent will implement EHS measures together with the Contractor by:

× Implementing sustainable project actions.
× Enhancing job-safe and efficient productivity measures.

× Taking environmental, social and governance proactive steps, and.

× Improving work quality and greater employee satisfaction amongst other EHS elements.

The overall EHS goals include the following: Zero accidents, no harm to people and no damage to the environment. To achieve these goals, the Proponent and the Contractor will be required to always apply best practices.

### 3.6.3 Environmental, Social, and Governance (ESG)

The Proponent has a clear Corporate Social Responsibility (CSR) guiding principles aligned with the expectations of communities and other stakeholders. The Environmental, Social and Governance (ESG) criteria of the Proponent provide a basis for measuring the performance against the global standards that have been committed to; in particular, information on the project activities, in relation to measurable norms. The following is the summary of the key measurable performance criteria:

× Environmental: Strive to partner with others and to be a steward of the natural environment in the areas of operations

× Social: Assess the fairness, transparency, and effectiveness of the interactions with communities, stakeholders and partners including suppliers and contractors.

× Governance: Allows the monitoring of the progress and improvements made on the goal of equitable decision-making and to determine the effectiveness of the internal controls in meeting the commitments to stakeholders and shareholders and the obligations to regulators.

The Proponent is committed to doing business in compliance with the Code of Business Conduct and Ethics and the associated company policies. The Proponent adheres to the Extractive Sector Transparency Measures Act (ESTMA).

### 3.6.4 Community Relations

ReconAfrica has become part of the northern Namibian community. The reality on the ground in both the Kavango East and West Region is the clear effects of inherited generational poverty, under development and lack of economic opportunities. Access to clean drinking water is hard to come by and for many women the daily reality involves walking up to 10km each way, to the “local” area where they source water (Plate 3.4).

Local community members, the Namibian Government and the Proponent are all committed to meaningfully and positive impacts on the lives of the local residents by drilling potable water wells closer to their homesteads (Plate 3.5). The commitment of the Proponent in alleviating this daily hardship is demonstrated by several water wells that will be drilled and hand over to the local communities as a result of the ongoing and proposed project activities in the local area.

### 3.6.5 Social Responsibility

ReconAfrica’s goal is to provide responsible energy development and power independence to Namibia. The Proponent is committed to conducting safe operations, respecting communities and other stakeholders and protecting the environment in Namibia. To support these commitments, the Proponent has incorporated environmental, social and governance norms and standards in current ongoing and planned project activities and business ventures (https://reconafrica.com).
Plate 3.4: Example of the true realities on the ground and effects of inherited generational poverty, under development and lack of economic opportunities in both Kavango West and East Regions: Leopaldine Mundombe, 18-year-old mother of a six-month old baby boy would walk for 6km, with her baby on her back at times, to fetch fresh drinking water. Insert: Women and children in the communities and villages around Rundu have to walk for many kilometres for potable water. They often carry up to 20 litres of water for distances sometimes up to 10 km (Source: https://reconafrica.com).
Plate 3.5: One of the completed community water wells programme handed over to the community of Mutwegombahe, a demonstration of the Proponent's commitment to uplifting the lives of the local community (Source: https://reconafrica.com).
### 3.6.6 2D seismic survey Contractors Operational Manuals and Policies

The Contractor will be undertaking the proposed 2D seismic survey operation will be required to prepare a comprehensive Health, Safety and Environment (HSE) operational standards, manuals, and policies for approval by the ReconAfrica.

The following HSE Contractor documentations will be required and will link directly to the EMP framework as well as the sustainability, health, safety, environment and social governance documentations of the Proponent:

- Bridging Document.
- Project HSE Plan.
- Waste Management Plan.
- Journey Management Plan.
- Grievance Mechanism, and.
- Cultural Heritage Procedure.
4. LEGISLATIVE FRAMEWORK

4.1 Overview

The statutes, common, customary, and international laws are the four (4) sources of laws as enshrined in the constitution which is the supreme law of Namibia. All other laws must be in line with the Namibian Constitution. The most important legislative instruments and associated authorisations, permits, licenses, concerts, compliances applicable to the proposed petroleum exploration activities (2D Seismic Survey) include: Petroleum, environmental management, land rights, water, atmospheric pollution prevention, health, and labour as well as other indirect laws linked to the accessory services associated with the proposed exploration technique (2D seismic Survey).

4.2 Key Applicable Legislation

4.2.1 Petroleum (Exploration and Production) Legislation

The national legislation governing petroleum operations in Namibia falls within the authority of the Ministry of Mines and Energy (MME) as the Competent Authority (CA) responsible for granting authorisations, permits, licenses, concerts, compliances as may be applicable to a petroleum exploration project. The legislative framework governing upstream oil and gas operations in Namibia is modern and well developed, and has been specially formulated for the international oil industry covering the following:


The Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991) is administered by the Petroleum Commissioner in the Ministry of Mines and Energy (MME) which is the Competent Authority. Under the Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991) the following Petroleum Upstream Licences may be granted to any applicant who may meet the requirements to be granted such a license:

(i) Petroleum Reconnaissance Licence (PRL): A reconnaissance licence allows its holder to carry on reconnaissance operations subject to terms and conditions as stipulated under Section 22-28 of the Act. A reconnaissance Licence is non-exclusive.

(ii) Petroleum Exploration Licence (PEL): An exploration licence allows its holder to carry on exploration operations exclusively in the block(s) to which it relates subject to the terms and conditions and in the block(s) as may be specified in such Licence as stipulated under Section 29-38 of the Act.

(iii) Petroleum Production Licence (PPL): A production licence allows its holder to exclusively carry-on production operations on the block(s) to which that licence relates and to sell or dispose of petroleum recovered within such block(s) and any other activities as stipulated under subsections 39-43 of the Act. Only one (1) production License has so far been issued in Namibia covering the Kudu Gas field situated offshore in the Orange Basin near the border between Namibia and South Africa.


extension of the duration of exploration licences; to further regulate the obligation of holders of exploration licences in terms of the terms and conditions of any such licences; to rectify the provisions of section 41 in relation to discoveries which are of commercial interest; to provide for the submission of decommissioning plans together with applications for production licences; to make different provision for the royalty payable on petroleum in respect of licences issued after the commencement of this Act; to further regulate the annual charges payable by holders of exploration and production licences; and to provide for the decommissioning of facilities on the cessation of production operations; to amend the Petroleum Taxation Act, 1991 (Act 3 of 1991), so as to reduce the rate of petroleum income tax; to provide for the allowance of deductions in respect of annual contributions to trust funds established for purposes of decommissioning of facilities in certain areas; to levy tax on surplus amounts in such trust funds; to provide for the allowance of deductions in respect of exploration expenditure incurred in any one or more other licence areas where no gross income was received; to make other provision for additional profits tax payable by the holders of production licences issued after a certain date; and to make further provision for the modification of Part III by virtue of terms and conditions contained in a petroleum agreement in relation to participation by the National Petroleum Corporation of Namibia (Namcor) in exploration or production operations; and to provide for incidental matters.

4.2.2 How to Apply for a Petroleum Exploration License

In the absence of an auctioning licensing regime process, any individual or entity can submit an application for a Reconnaissance or Exploration Licences to the Ministry of Mines and Energy (MME) and the system is open and does not support lobbyists at all. An application for a license may be granted subjected to the terms and conditions as stipulated in the Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991).

The first step before an application can even be prepared and submitted to the Ministry of Mines and Energy, an applicant will need to develop a clear regional and local theoretical hydrocarbon model centred on a fully or partially known or assumed knowledge-base with key boundary conditions that must be tested and validated during the exploration process of building the knowledge-base. An application is often prepared by a technical team comprising Geological/ Petroleum Consultants with full technical and financial knowledge about petroleum exploration operations, regional and local geology and possible petroleum systems in Namibia.

An application will usually detail the proposed theoretical hydrocarbon model with key boundary conditions and provides a detailed process by which the proposed theoretical hydrocarbon model is going to be validated and this process is called exploration programme with detailed budget breakdowns. The cost for preparing such an application by the Consultants can be as high as USD10,000.00 or more and this cost excludes technical data sets that must be purchased from the Government and sold in USD. Depending on the size of the license area, existing data set costs can be as high as USD50,000.00. There is zero guarantee of recovering the cost of preparing the application and chance of the application being granted once submitted to the Government.

Following the lodgement of such an application to the Ministry of Mines and Energy, and the payment of the non-refundable fee of N$30,000.00 per application, a standard Model Petroleum Agreement (MPA) is given to the applicant if the application has been formally accepted by the Government (Ministry of Mines and Energy). The MPA is usually reviewed by the technical, financial, and legal teams from both the applicant and the Government of Namibia.

Once a date for negotiating the Petroleum Agreement (PA) has been agreed, the technical, financial and legal teams from both the applicant and the Government of Namibia meet to negotiate the terms and conditions of the PA covering exploration and possible production conditions in an event of a commercial discovery. The applicant will be required to lodge a guarantee against any non-performance related to the committed exploration programme and expenditure. The exploration activities and expenditures guarantee is usually in the range of 10% of the exploration budget. Under Section 13 of the Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991), the Minister of Mines and Energy is required to enter into a Petroleum Agreement with an applicant for a petroleum exploration license before he/she grants such license.
Once the Petroleum Agreement has been agreed and the annually recurring license fees charged between N$60.00 to N$150 per square kilometre which is about N$650, 000.00 for an average Degree Square Block as well as a mandatory annual contribution of around N$1.2 million to the Petroleum Training and Education Fund (PetroFund) are paid, a Petroleum Exploration License is granted to the applicant by the Minister of Mines and Energy in accordance with the provisions of the Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991). Finally, a Joint Operating Agreement (JOA) with NAMCOR (State Owned Company) or any other joint venture partner/s participating in the license is negotiated and the proposed exploration activities aimed at testing and validating the developed theoretical hydrocarbon model can now be implemented and monitored by the Ministry of Mines and Energy with annual reporting through a Technical Advisory Committee (TAC).

4.2.3 Key Important Clauses of a Petroleum Agreement

4.2.3.1 Overview

The Petroleum Agreement gives a holder of PEL a right to the grant of an initial exploration license for a period not to exceed four (4) years (www.mme.gov.na). This may be renewed for further periods not exceeding two (2) years on each occasion. In general, a PEL may be renewed only twice. The Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991) empowers the Minister of Mines and Energy to extend the initial exploration period and the renewal periods by up to 12 months each in response to any operational exigencies of particular licensees.

The Petroleum Agreement makes provision for the PEL holder to commit to a minimum exploration work program as stated in the initial application. The Government often negotiates specially tailored exploration work programs for each PEL as may be applicable. The Petroleum Agreement also provides for the second and third tier rates of the Additional Profits Tax and the Training and Education Fee and the negotiated figures on these items are provided into the relevant clauses in the Petroleum Agreement. The Petroleum Agreement sets out the procedure to be followed by a licensee on discovery of petroleum.

The licensee is forthwith to inform the Commissioner for Petroleum Affairs and then to evaluate the discovery to determine whether it is of potential commercial interest. If it is, the licensee has to take steps to appraise the discovery in accordance with an appraisal program in conformance with the requirements of the Petroleum Agreement. In an event of a commercial discovery expected that implementation of the appraisal program should be completed within two years although upon good cause shown to the Commissioner, he may extend the period.

The holder of a PEL who makes a commercial discovery is entitled to apply for a production license and, subject to complying with the requirements of the petroleum and other applicable legislations, is entitled to the grant of such license. A production license may be granted for a period not exceeding 25 years and may be renewed for such further period, not exceeding 10 years, as the Minister of Mines and Energy may determine at the time of such renewal request. A production license may be renewed only once. Among the many other clauses of the Petroleum Agreement is one that provides for a Technical Advisory Committee (TAC) consisting of an equal number of Government nominees and nominees of the licensee to monitor the petroleum operations of the licensee. The TACs under the First and Second Round Licenses proved to be a useful interactive forum between the Government and existing PEL holders in Namibia on the details of their petroleum operations.

4.2.3.2 Petroleum Agreement Environmental Protection Clause 11

Oil and gas exploration and production regulatory framework in Namibia provides for strict contractual obligations by a holder of PEL with respect to environmental performances as provided for in the Petroleum Model Agreement under the Environmental Protection Clause 11. The following is the extract from the Model Agreement, 2007, Environmental Protection Clause 11 which may be slightly different to the actual wording used in the onshore Petroleum Agreement for ReconAfrica but provides the general framework and obligations applicable for all PEL holders in Namibia:

11.1 The Minister and the Company concede that Petroleum Operations will cause some impact on the environment in the Licence Area.
11.2 The Company shall-

(a) conduct its Petroleum Operations in a manner likely to conserve the natural resources of Namibia and protect the environment.

(b) employ the best available techniques in accordance with Good Oilfield Practices for the prevention of Environmental Damage to which its Petroleum Operations might contribute and for the minimization of the effect of such operations on adjoining or neighbouring Lands, and.

(c) implement the proposals contained in its Development Plan regarding the prevention of pollution, the treatment of wastes, the safeguarding of natural resources and the progressive reclamation and rehabilitation of Lands disturbed by Petroleum Operations.

11.3 The Company undertakes for purposes of this Agreement to take all reasonable, necessary, and adequate steps in accordance with Good Oilfield Practices to minimize Environmental Damage to the Licence Area and adjoining or neighbouring Lands.

11.4 If the Company fails to comply with the terms of clause 11.3 or contravenes any law on the prevention of Environmental Damage and such failure or contravention results in any Environmental Damage, the Company shall take all necessary and reasonable measures to remedy such failure or contravention and the effects thereof.

11.5 If the Minister has reason to believe that any works or installations erected by the Company or any operations carried out by the Company are endangering or may endanger persons or any property of any other person or is causing pollution or is harming wildlife or the environment to a degree which the Minister deems unacceptable, the Minister may require the Company to take reasonable remedial measures within such reasonable period as may be determined by the Minister and to take reasonable and appropriate steps to repair any damage to the environment. If the Minister deems it necessary, he may require the Company to discontinue Petroleum Operations in whole or in part until the Company has taken such remedial measures or has repaired any damage.

11.6 The measures and methods to be used by the Company for purposes of complying with the terms of clause 11.3 shall be determined in timely consultation with the Minister upon the commencement of Petroleum Operations or whenever there is a significant change in the scope or method of carrying out Petroleum Operations, and the Company shall take into account the international standards applicable in similar circumstances and the relevant environmental impact assessment studies carried out in accordance with clause 11.7.

11.7. The Company shall notify the Minister in writing of the nature of the measures and methods finally determined by the Company and shall cause such measures and methods to be reviewed from time to time in view of prevailing circumstances.

11.7 The Company shall cause a person or persons, approved by the Minister on account of their special knowledge of environmental matters, to carry out two environmental impact assessment studies, in order

(a) to determine the prevailing situation relating to the environment, human beings, wildlife or marine life in the Licence Area and in the adjoining or neighbouring areas at the time of the studies; and (b) to establish what the effect will be on the environment, human beings, wildlife in the Licence Area in consequence of the Petroleum Operations to be made under this Agreement, and to submit for consideration by the Parties measures and methods contemplated in clause 11.6 for minimising Environmental Damage and carrying out Site Restoration in the Licence Area.
11.8 The first of the two studies referred to in clause 11.7 shall be carried out in two parts. The first part of the first study shall be a baseline study of existing information on the environment, human beings, wildlife in the Licence Area. The company shall conclude such baseline study prior to undertaking any fieldwork for a seismographic survey. The second part of the first study shall be an environmental impact assessment study of the effects of drilling on the environment. This environmental impact assessment study is to be concluded sufficiently in advance of the commencement of drilling to enable the results of this environmental impact assessment study to be considered in preparing all relevant drilling management, waste management and contingency plans relating to the exploration drilling stage.

11.9 The second of the two studies referred to in clause 11.7 shall be an environmental impact assessment study of the effects of production on the environment and shall be concluded sufficiently in advance of the commencement of Production Operations to enable the results of this environmental impact assessment study to be taken into account in preparing all relevant production management, waste management and contingency plans relating to Production Operations and shall be submitted by the Company as part of its Development Plan.

11.10 The studies mentioned in clause 11.7 shall contain proposed environmental guidelines to minimise Environmental Damage and shall include, but not be limited to:

(a) Access cutting.

(b) Clearing and timber salvage.

(c) Wildlife and habitat protection.

(d) Resource protection.

(e) Fuel storage and handling.

(f) Use of explosives.

(g) Camps and staging areas.

(h) Liquid and solid waste disposal.

(i) Cultural and archaeological sites.

(j) Selection of drilling sites.

(k) Terrain stabilisation.

(l) Protection of freshwater horizons.

(m) Blowout prevention plan.

(n) Combating oil spills.

(o) Flaring during completion and testing of gas and oil wells.

(p) Well abandonment.

(q) Rig dismantling and site completion.

(r) Reclamation for abandonment, and

(s) noise control.
11.11 The Company shall ensure-

(a) that Petroleum Operations are carried out in an environmentally acceptable and safe manner consistent with Good Oilfield Practices and that such operations are properly monitored.

(b) that the pertinent completed environmental impact assessment studies are made available to its employees and to its contractors to develop adequate and proper awareness of the measures and methods of environmental protection to be used in carrying out its Petroleum Operations.

(c) that any agreement entered between the Company and its contractors relating to its Petroleum Operations shall include the terms set out in this Agreement and any established measures and methods for the implementation of the Company's obligations in relation to the environment under this Agreement.

11.12 The Company shall, before carrying out any drilling, prepare and submit for review by the Minister an oil spill and fire contingency plan designed to achieve rapid and effective emergency response in the event of an oil spill or fire.

11.13 In the event of-

(a) an emergency or accident arising from Petroleum Operations affecting the environment, the Company shall forthwith notify the Minister accordingly.

(b) any fire or oil spill, the Company shall promptly implement the relevant contingency plan.

(c) any other emergency or accident arising from the Petroleum Operations affecting the environment, the Company shall take such action as may be prudent and necessary in accordance with Good Oilfield Practices in such circumstances.

11.14 If the Company fails to comply with any terms contained in clause 11 within a period determined by the Minister under any such term, the Minister may, after giving the Company reasonable notice, take any action which may be necessary to ensure compliance with such term, and recover, immediately after having taken such action, all expenditure incurred in connection with such action from the Company together with such interest as may be determined in accordance with paragraph 6.2 of Annexure 4 to this Agreement.

11.15 If the Company or the operator for the Company has already completed and submitted to the Government reports on the studies referred to in clause 11.8 for a previous Exploration Licence held in Namibia in the 5-year period preceding the application for this Exploration Licence and those studies either

(a) are sufficiently broad ranging to encompass clearly the present Licence Area, or

(b) do not encompass the present Licence Area but a baseline study and environmental impact assessment study have been submitted by the holder of an Exploration Licence covering an area near the present Licence Area the Company may, in a case falling within (a) above, submit the reports on the studies for such previous Licence in fulfilment of the requirements of clauses 11.7 and 11.8 relating to exploration drilling and, in a case falling within (b) above submit such environmental impact assessment submitted by the said holder of an Exploration Licence, with any modifications which the Company wishes to make provided that:
(i) In response to a written request from the Company, the Minister approves in writing the course of action selected from (a) or (b) above.

(ii) In response to a written request from the Company directed through the Ministry of Mines and Energy, the Ministry of Environment, Tourism and Forestry, the Ministry of Works, Transport and Communication and the Ministry of Health and Social Services also approve in writing the course of action selected from (a) or (b) above.

(iii) The company that carried out the baseline study and environmental impact assessment study which are to be submitted in terms of (b) above agrees to this course of action.

(iv) The baseline study and the environmental impact assessment study submitted in terms of (b) above encompass the present Licence Area.

(v) Fluids, muds and chemicals to be used during drilling are the same as those used in the Exploration Licence covered by the environmental impact assessment study submitted.

(vi) Any other special studies relevant to an environmental impact assessment of the effect of drilling on the environment in the present Licence Area as may be required by the Minister are carried out and the results thereof together with plans for mitigating actions be submitted in the form of reports to the Government. A minimum of 12 copies of these reports are to be submitted.

(vii) The results of the resubmitted environmental impact assessment study as well as the studies conducted under (v) above are taken into account in preparing all relevant drilling management, waste management and contingency plans relating to the exploration drilling stage.

(viii) An amount equal to half the average cost of the three most recent baseline and environmental impact assessment studies complying with the requirements of the first of the studies in clause 11.7 for offshore oil exploration in Namibia or such other amount as may be agreed between the Parties is paid to the National Petroleum Corporation of Namibia (NAMCOR). This money shall be used by NAMCOR in accordance with the principles laid out in Annexure 7 in order to collect offshore environmental data relevant to oil exploration and production in Namibia. Projects to be undertaken by NAMCOR in this connection shall be decided upon in consultation with the oil exploration companies operating in Namibia and with the Ministry of Environment, Tourism and Forestry.

11.16 The Company shall on the expiration or termination of this Agreement or on relinquishment of part of the Licence Area-

(a) subject to clause 17, remove or otherwise deal with, as directed by the Minister in consultation with the Minister or Ministers responsible for environment, fisheries and finance, all equipment and installations from such Licence Area or relinquished area to the extent and in the manner agreed with the Minister in terms of the Decommissioning Plan approved by the Minister pursuant to s.68A(2) of the Petroleum Act.

(b) subject to clause 17, remove, or otherwise deal with, as directed by the Minister in consultation with the Minister or Ministers responsible for environment, fisheries and finance, all installations, equipment, pipelines, and other facilities erected or used outside the Licence Area for the petroleum operations.
perform all necessary Site Restoration activities in accordance with Good Oilfield Practices and shall take all other action necessary to prevent hazards to human life or to the property of others or the environment.

11.17 The Company shall on the date referred to in s.68B(1) of the Petroleum Act establish a Trust Fund in accordance with the provisions of s.68(B) of the said Act for the purpose of decommissioning facilities on cessation of production operations.

4.3 Other Key Applicable Legislation

4.3.1 Environmental Management Legislation

The Environmental Assessment (EA) process in Namibia is governed by the Environmental Impact Assessment (EIA) Regulations No. 30 of 2012 gazetted under the Environmental Management Act, (EMA), 2007, (Act No. 7 of 2007) in the Ministry of Environment, Forestry and Tourism (MEFT). The objectives of the Act and the Regulations are, among others, to promote the sustainable management of the environment and the use of natural resources to provide for a process of assessment and control of activities which may have significant effects on the environment. The Minister of Environment, Forestry and Tourism (is authorised to list activities which may only be undertaken if an environmental clearance certificate has been issued by the environmental commissioner, which activities include those relating to oil and gas exploration and production operations.

The proposed 2D seismic survey operations in PEL 73 area of interest falls within the categories of listed activities that cannot be undertaken without an Environmental Clearance Certificate (ECC). The current ECC granted in August 2019 allows the Proponent to continue with oil and gas exploration activities focused on the drilling of stratigraphic wells only. All the other subsequent exploration activities listed in the EIA Regulations and as may also be provided for in the

In addition to the requirements for undertaking Environmental Assessment prior to the project implementation, the Environmental Management Act and the EIA Regulations also provide for obligations of the PEL holder to provide for project rehabilitation and closure plan. In the regulations, the definition of rehabilitation and closure plan is a plan which describes the process of rehabilitation of an activity at any stage of that activity up to and including closure stage.

4.3.2 Communal Land Rights

The proposed 2D seismic survey operations cover the communal land of Kavango West and East regions administered by various traditional authorities through Regional Communal Land Boards. Communal land is land that belongs to the State and is held in trust for the benefit of the traditional communities living in those areas. Communal land cannot be bought or sold, but you can be given a customary land right or right of leasehold to a part of communal land in accordance with the provisions of the Communal Land Reform, 2002, (Act No. 5 of 2002).

The Communal Land Reform, 2002, (Act No. 5 of 2002) provide for the allocation of rights in respect of communal land. to establish Communal Land Boards. to provide for the powers of Chiefs and Traditional Authorities and boards in relation to communal land and to make provision for incidental matters. However, communal land is still owned by the State with the allocation of user rights delegated to the traditional authority.

Consent and access to land for the proposed 2D seismic survey shall be channel to the relevant traditional authority through the Regional Council. Written request for consent shall be send through the Office of Governors for Kavango West and East Regions.

4.3.3 Water Legislation

Water Act 54 of 1956 under the Minister of Agriculture, Water and Land Reform (MAWLR) provides for the control, conservation and use of water for domestic, agricultural, urban, and industrial purposes. In terms of Section 6, there is no right of ownership in public water and its control and use is regulated
and provided for in the Act. In accordance with the Act, the ongoing exploration operations must ensure that mechanisms are implemented to prevent water pollution. Certain permits will also be required to abstract groundwater as well as for ‘water works’ which is not required for the proposed 2D seismic survey operations. The broad definition of water works will include the reservoir on Site (as this is greater than 20,000m³), water treatment facilities and pipelines not applicable for the proposed 2D seismic survey. Due to the water scarcity of the area, all water will be recycled (including domestic wastewater as may be applicable). The Act may require the Proponent to have a wastewater discharge permit for discharge of effluent from the camp site if not equipped with portable chemical toilets.

**4.3.4 Atmospheric Pollution Prevention Legislation**

The Atmospheric Pollution Prevention Ordinance, 11 of 1976 falling under the Ministry of Health and Social Services (MHSS) provide for the prevention of the pollution of the atmosphere, and for matters incidental thereto. Part III of the Act sets out regulations pertaining to atmospheric pollution by smoke. While preventative measures for dust atmospheric pollution are outlined in Part IV and Part V outlines provisions for Atmospheric pollution by gases emitted by vehicles.

**4.3.5 Labour, Health and Safety Legislations**


In terms of the Health Safety and Environment (HSE), the Labour Act, 2007 protects employees and every employer shall, among other things: provide a working environment that is safe, without risk to the health of employees, and that has adequate facilities and arrangements for the welfare of employees, provide and maintain plant, machinery and systems of work, and work processes, that are safe and without risk to the health of employees, and ensure that the use, handling, storage or transportation of hazardous materials or substances is safe and without risk to the health of employees.

All hazardous substances shall have clear exposure limits and the employer shall provide medical surveillance, first-aid and emergency arrangements as fit for the operation.

**4.3.6 Coronavirus (COVID-19) Pandemic, Emergencies and Health Restrictions**

The proposed 2D seismic survey operations will mobilisation of equipment and limited specialist personnel from abroad. The current global Coronavirus (COVID-19) pandemic and the associated State of Emergencies and health restrictions globally will result in some delays and logistic disruptions.

Locally, Namibia might have State of Health Emergency on top of the current escalating health restrictions under the Public and Environmental Health Act, 2015 (Act No. 1 of 2015) that may also affect not equipment and specialist workforce mobilisation but also the actual field implementation of the project. The local COVID 19 health restrictions will affect the field campsite set-up, vehicles passengers and field survey and all aspects of the proposed project.

The Proponent through the Contractor and subcontractors shall adhere to all the international, regional, and local COVID 19 health restrictions and protocols that may be in place at the time of conducting the survey.

**4.3.7 Summary of Applicable National Legislations**

The following is the summary of the important legislative that may be applicable to the proposed 2D seismic survey operations are:

- Namibian Constitution Articles 91(c) and 95.
× Environmental Management Act (No. 7 of 2007) and Regulations (2012).
× Water Act, 1956, Act No. 54 of 1956.
× Public and Environmental Health Act, 2015 (Act No. 1 of 2015)
× Health Act (No. 21 of 1988).
× Air Quality Act (No. 39 of 2004).
× Atmospheric Pollution Prevention Act (No. 45 of 1965).
× Communal Land Act (No. 10 of 2002).
× Communal Land Reform Amendment Act (No. 13 of 2013).
× Forestry Act (No. 12 of 2001) and Forest Amendment Act (No. 13 of 2005).
× National Heritage Act (No. 27 of 2004).
× Nature Conservation Amendment Act (No. 5 of 1996).
× Nature Conservation Ordinance (No. 4 of 1975).
× Soil Conservation Act (No. 70 of 1969), and.
× Traditional Authorities Act (No. 17 of 1995).

4.4 Regulatory Agencies and Permits Register

4.4.1 Key Regulatory Permits and Agencies

Government agencies with permits responsibilities over the proposed project activities are shown in Table 4.1. Table 4.2 shows the relevant permits / licenses required with respect to the proposed 2D seismic survey. Namibia only has standards and guidelines with respect to the freshwater and wastewater and lacks gaseous and noise limits.

The comparative water quality guideline is shown in Table 4.3. The industrial effluent likely to be generated by the proposed operations if any, must comply with provisions of the Government Gazette No 217 dated 5 April 1962 (Table 4.4).
Table 4.1: Government agencies with permits responsibilities over the proposed project activities.

<table>
<thead>
<tr>
<th>AUTHORITY</th>
<th>TYPE OF AUTHORISATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office of the Environmental Commissioner (OEC), Ministry of Environment, Forestry and Tourism</td>
<td>Issue of Environmental Clearance Certificate (ECC) based on the review of the Environmental Assessments (EA)Reports prepared in accordance with the Environmental Management Act (2007) and the Environmental Impact Assessment Regulations, 2012</td>
</tr>
<tr>
<td>Ministry of Mines and Energy (MME)</td>
<td>Competent Authority overseeing all matters related to petroleum exploration and production activities in Namibia. MME is responsible for issuing of all types of Petroleum Licenses / Authorisation.</td>
</tr>
<tr>
<td>Ministry of Agriculture, Water and Land Reform</td>
<td>The Directorate of Resource Management within the Department of Water Affairs (DWA) is currently the lead agency responsible for management of surface and groundwater utilisation through the issuing of abstraction permits and waste water disposal permits. DWA is also the Government agency responsible for water quality monitoring and reporting. The National Botanical Research Institute (NBRI) mandate is to study the flora and vegetation of Namibia, to promote the understanding, conservation and sustainable use of Namibian plants for the benefit of all. The Directorate of Forestry (DOF) is responsible for issuing of forestry permits with respect to harvest, transport, and export or market forest resources.</td>
</tr>
<tr>
<td>Kavango West and East Regional Councils</td>
<td>Overall responsibility of management of regional land resources and allocation of communal land user rights as may be required by the proposed project. Any Lease Agreement or surface land user rights in Communal Land must be approved by the Minister of Urban and Rural Development</td>
</tr>
<tr>
<td>Kavango West and East Regions Traditional Authorities</td>
<td>Traditional authorities in Namibia are the custodians of State land falling within authority of the respective tribal authority. With the approval of the Regional Land Boards, traditional authorities are responsible for allocation communal land user rights to the local communities. Consent to use communal land for the proposed 2D seismic survey shall be obtained from the relevant traditional authorities as may be applicable.</td>
</tr>
</tbody>
</table>

Table 4.2: Summary of the permit register.

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>APPLICABLE LEGISLATION</th>
<th>PERMITTING AUTHORITY</th>
<th>ASSESSMENT RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Clearance Certificate (ECC) for proposed 2D Seismic Survey</td>
<td>Environmental Management Act (2007) and the Environmental Impact Assessment Regulations, 2012</td>
<td>Ministry of Environment, Forestry and Tourism (MEFT)</td>
<td>Still to be Issued</td>
</tr>
<tr>
<td>Discharge of effluents or construction of effluent facility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Removal, disturbances, or destruction of bird eggs</td>
<td>Nature Conservation Ordinance 4, 1975.</td>
<td>Ministry of Environment, Forestry and Tourism (MEFT)</td>
<td>No removals of protected species or mature trees anticipated because the activities will only require the widening the already existing tracks as may be applicable</td>
</tr>
<tr>
<td>Removal, disturbance of protected plants.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Removal, destruction of indigenous trees, bushes, or plants within 100 yards of stream or watercourse.</td>
<td>Forestry Act, 12 of 2001.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>------------------------------------------------</td>
<td>------------------------------------------------</td>
<td>------------------------------------------------</td>
</tr>
<tr>
<td>Parameter Value</td>
<td>Maximum Admissible Concentration (MAC)</td>
<td>Maximum Contaminant Level (MCL)</td>
<td>Group A Excellent Quality</td>
</tr>
<tr>
<td>Vanadium</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Uranium</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Thallium</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Nitrate*</td>
<td>mg/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mercury</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Arsenic</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Barium</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Bismuth</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Boron</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Bromate</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Bromine</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cadmium</td>
<td>mg/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Calcium</td>
<td>mg/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cerium</td>
<td>mg/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Chloride</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Chromium</td>
<td>mg/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cobalt</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Copper after 12 hours in pipe</td>
<td>mg/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Cyanide</td>
<td>mg/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Fluoride</td>
<td>mg/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Gold</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Hydrogen sulphide</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lead</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Lithium</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Magnesium</td>
<td>mg/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Manganese</td>
<td>mg/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Mercury</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>mg/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Nickel</td>
<td>mg/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Nitrate*</td>
<td>mg/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Nitrate*</td>
<td>mg/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Oxygen, dissolved</td>
<td>mg/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>mg/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Potassium</td>
<td>mg/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Selenium</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Silver</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sodium</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sulphate</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tellurium</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Thallium</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tin</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Titanium</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Zinc after 12 hours in pipe</td>
<td>μ g/l</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

P: Provisional R: May give reason to complaints from consumers C: Current P: Proposed S: Secondary
TT## treatment technique triggered at action level of 1300 μ g/l

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### Table 4.4: R553 Regional Standards for Industrial Effluent, in Government Gazette No 217 dated 5 April 1962.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limitation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour, odour and taste</td>
<td>The effluent shall contain no substance in concentrations capable of producing colour, odour or taste</td>
</tr>
<tr>
<td>pH</td>
<td>Between 5.5 and 9.5</td>
</tr>
<tr>
<td>Dissolved oxygen</td>
<td>At least 75% saturation</td>
</tr>
<tr>
<td>Typical faecal coli</td>
<td>No typical faecal coli per 100 ml</td>
</tr>
<tr>
<td>Temperature</td>
<td>Not to exceed 35 °C</td>
</tr>
<tr>
<td>Chemical demand oxygen</td>
<td>Not to exceed 75 mg/l after applying a correction for chloride in the method</td>
</tr>
<tr>
<td>Oxygen absorbed</td>
<td>Not to exceed 10 mg/l</td>
</tr>
<tr>
<td>Total dissolved solids (TDS)</td>
<td>The TDS shall not have been increased by more than 500 mg/l above that of the intake water</td>
</tr>
<tr>
<td>Suspended solids</td>
<td>Not to exceed 25 mg/l</td>
</tr>
<tr>
<td>Sodium (Na)</td>
<td>The Na level shall not have been increased by more than 50 mg/l above that of the intake water</td>
</tr>
<tr>
<td>Soap, oil and grease</td>
<td>Not to exceed 2.5 mg/l</td>
</tr>
<tr>
<td>Other constituents</td>
<td></td>
</tr>
<tr>
<td>Residual chlorine</td>
<td>0.1 mg/l as Cl</td>
</tr>
<tr>
<td>Free &amp; saline ammonia</td>
<td>10 mg/l as N</td>
</tr>
<tr>
<td>Arsenic</td>
<td>0.5 mg/l as As</td>
</tr>
<tr>
<td>Boron</td>
<td>1.0 mg/l as B</td>
</tr>
<tr>
<td>Hexavalent Cr</td>
<td>0.05 mg/l as Cr</td>
</tr>
<tr>
<td>Total chromium</td>
<td>0.5 mg/l as Cr</td>
</tr>
<tr>
<td>Copper</td>
<td>1.0 mg/l as Cu</td>
</tr>
<tr>
<td>Phenolic compounds</td>
<td>0.1 mg/l as phenol</td>
</tr>
<tr>
<td>Lead</td>
<td>1.0 mg/l as Pb</td>
</tr>
<tr>
<td>Cyanide and related compounds</td>
<td>0.5 mg/l as CN</td>
</tr>
<tr>
<td>Sulphides</td>
<td>1.0 mg/l as S</td>
</tr>
<tr>
<td>Fluorine</td>
<td>1.0 mg/l as F</td>
</tr>
<tr>
<td>Zinc</td>
<td>5.0 mg/l as Zn</td>
</tr>
</tbody>
</table>

### 4.5 International Standards, Treaties and Protocols

#### 4.5.1 Applicable International Standards

The Constitution of the Republic of Namibia, the Environmental Management Act, (EMA), 2007, (Act No. 7 of 2007) and the Environmental Impact Assessment (EIA) Regulations No. 30 of 2012 as well as other associated laws with respect to exploration, petroleum exploration and production, land, energy, labour and health and safety all provides for the mechanism of assessing key issues associated with development projects in Namibia.

The only key missing components to the regulatory frameworks in Namibia are benchmarks, limits, standards, and guidelines with respect to gaseous, liquid, and solid emissions. However, in the absence of national gaseous, liquid, and solid emission limits for Namibia, the proposed project shall target the Multilateral Investment Guarantee Agency (MIGA) gaseous effluent emission level and liquid effluent emission levels (Table 4.5). Noise abatement measures must target to achieve either the levels shown in Table 4.6 or a maximum increase in background levels of 3 dB (A) at the nearest receptor location off-site (MIGA guidelines).
Table 4.5: Liquid effluent emission levels (MIGA /IFC).

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Max. Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.9</td>
</tr>
<tr>
<td>Total suspended solids</td>
<td>50 mg/l</td>
</tr>
<tr>
<td>Total metals</td>
<td>10 mg/l</td>
</tr>
<tr>
<td>Phosphorous (P)</td>
<td>5 mg/l</td>
</tr>
<tr>
<td>Fluoride (F)</td>
<td>20 mg/l</td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>0.1 mg/l</td>
</tr>
</tbody>
</table>

Table 4.6: Noise emission levels (MIGA /IFC).

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Maximum Allowable Leq (hourly), in dB(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Day time (07:00 ï–½ 22:00)</td>
</tr>
<tr>
<td>Residential, institutional, educational</td>
<td>55</td>
</tr>
<tr>
<td>Industrial, commercial</td>
<td>70</td>
</tr>
</tbody>
</table>

4.5.2 International and Regional Treaties and Protocols

Article 144 of the Namibian Constitution provides for the enabling mechanism to ensure that all international treaties and protocols are ratified. All ratified treaties and protocols are enforceable within Namibia by the Namibian courts and these include the following:

× The Paris Agreement, 2016.
× World Heritage Convention, 1972.


4.6 Recommendations on Regulatory Framework and Best Practices

The regulatory framework applicable to the proposed 2D seismic survey has been reviewed during the EIA process. The proposed 2D seismic survey operation shall meet all the applicable national legislation, regulations, standards, and guidelines, international and regional regulatory frameworks, standards, treaties, and protocol.

Further industry standards for conducting onshore seismic survey operations are also available from International Association of Geophysical Contractors (IAGC). The IAGC is the global trade association representing all segments of the geophysical and exploration industry (www.iagc.org). The IAGC provides guidance materials and industry best practices for land seismic operations.

It is hereby recommended that the Proponent shall comply with the provisions of all relevant and applicable national regulatory requirements in Namibia. Local community, cultural, religious, and traditional practices as well as fair labour relations and greater emphasis on local hire shall always be observed with continuous engagement with the traditional authorities and Regional Councils as well as the Ministry of Mines and Energy (Competent Authority), the Ministry of Environment, Forestry and Tourism (Regulator) and the Ministry of Agriculture, Water and Land Reform (Regulator) as may be applicable and as detailed in Tables 4.1 and 4.2.
5. RECEIVING ENVIRONMENT

5.1 Climatic and Topographic Settings

The climate of the project area is warm – hot for the most of the year. Summer temperatures on average range between a minimum temperature of 20°C to maximum day temperatures of 30-35°C for months October to March. Winter temperatures on average, range between minimums of 6-10°C to a maximum day time temperature of 26°C. Winters are from June to August. Temperatures below freezing point seldom occur, but are mostly prevalent in topographically lower lying areas along the ephemeral rivers. The highest day time temperature recorded was 41°C, at Rundu.

Rainfall decreases generally from north to south, with an even gradient across the flat landscape. Rainfall mostly falls during summer with no rainfall of significance between May to August. Most rain occurs between December to March, with the highest rainfall peaking in January (Plate 5.1). Annual rainfall figures are quite variable with the lowest rainfall recorded at 221mm/annum and the highest rainfall of 1204mm/annum. The highest rainfall in one day was a 190mm, measured at Rupara. Rainfall in the Kavango as for the rest of Namibia are highly variable spatially and temporally.

The mean annual rainfall is highly variable between 400 and 600 mm per year (Fig. 5.1). The distribution of rainfall is extremely seasonal with all the rain falling in summer from October to April and characterised by heavy occasional thunderstorms (Plate 5.1). The mean annual gross evaporation is between 2600-2800 mm (Fig. 5.1).

The Kavango Region is a flat gently sloping landscape formed by a sea of windblown sands. The only positive relief are undulating, east-west striking, permanent dunes prominent in the west of the Omatako Omuramba and further east, closer to Botswana. Dune crests are approximately between 10-15m high with interstitial dune valleys between 1-2km wide.

The terrain, from east to west, has a height difference of approximately 100m over a 300km distance, with heights of approximately 1200 metres above mean sea level (mamsl) in the west falling to approximately 1080 mamsl in the east at the border with Botswana (Fig. 5.2).

Fig. 5.2 shows the topographic profile of the general project area with east to west and north to south cross sections. The Omatako Omuramba is a prominent feature, as observed at the 200km mark of the profile. The general topographic profile of the project area from south to north has heights of 1200 mamsl in the south falling to 1070 mamsl in the north close to and beyond the Okavango Reiver.
Plate 5.1: Climatic patterns and typical afternoon heavy rainfall with occasional thunderstorms in Kavango West and East Regions. The main rainy season period from December to March will not be suitable to conduct the proposed 2D seismic survey operations due to difficulty access in some areas and cultivated subsistence crop fields.
Figure 5.1: Climatic patterns of Namibia showing the location of the proposed 2D seismic survey operations in Kavango West and East Regions.
Figure 5.2: General topography the project area with relief features such as the Omatako Omuramba valley and other smaller river valleys joining the Okavango River from the south (Julius, 2021).
5.2 Regional and Local Land Uses

5.2.1 Regional Land Use

The proposed project (2D seismic survey area) landscape is characterised by gentle undulating sandy topography of the forested / vegetated sandy Kalahari Dune Belt. The project survey area falls within the greater Kavango-Zambezi Transfrontier Conservation Area (KAZA TFCA) initiative (Fig. 5.3). The KAZA TFCA initiative covering Angola, Botswana, Namibia, Zambia, and Zimbabwe was created in cooperation with Peace Parks Foundation and the World-Wide Fund for Nature. In July 2006 SADC's endorsed the KAZA TFCA as a SADC project, and on 7th December 2006 the Ministers of Environment and Tourism of the five partner countries signed a Memorandum of Understanding at Victoria Falls, Zimbabwe, providing for work towards the establishment of the KAZA TFCA initiative (www.kavangozambezi.org/en).

KAZA TFCA is a multiple land use regional transboundary conservation initiative with a common vision of promoting and supporting sustainable livelihoods through coexistence and utilisation of multiple resource and resources areas including National Parks, Game Reserves, Forest Reserves, Conservancies, Game/Wildlife Management Areas and Communal lands (Fig. 5.3). The KAZA TFCA would also promote cross border tourism, linking some of the world's premier tourism destinations, including the Victoria Falls in Zimbabwe and the Okavango Delta in Botswana. The Namibian component of KAZA TFCA plays a pivotal role in providing migration routes for wildlife between Angola, Botswana, and Zambia (www.met.gov.na). The livelihoods of ordinary local people within KAZA TFCA inclusive of the proposed project areas highly dependent on seasonal subsistence agriculture, animal husbandry, fishing, natural resource harvesting, tourism, trading, and hunting.

5.2.2 Land Use of the Proposed Survey Area

The location the proposed survey area covering the key areas of interest within PEL 73 forms part of a low lying peneplain of the Omatako, Cubango-Cuito and Okavango surface water Basins (Fig. 5.4). The Omatako Ephemeral River channel and the associated Ephemeral tributaries are major landform features dominating the topographically low areas of the proposed 2D seismic survey area. The Omatako Ephemeral River joins the Cubango River near Rundu, but has not contributed to runoff from the Okavango for over 50 years (Oldeland et. al., 2013 and Plates 5.2 and 5.3). Formal proclaimed national parks bordering the proposed 2D seismic survey area are: Bwabwata, Khaudum and Mangetti National Parks (Fig. 5.5).

According to the Namibian Association of Community Based Natural Resource Management (CBNRM) Support Organisations (NACSO), there are 2 community forests in Kavango West (Kahengu and Katope community forests) and 10 community forests in Kavango East (Ncumacara, Ncamagoro, Mbeyo, Gcwatjingga, Ncaute, Cuma, Likwaterera, Hans Kanyinga, George Mukoya and Muduva Nyangana community forests) (Fig. 5.5). George Mukoya and Kapinga Kamwalye are the two (2) community conservancies situated to the eastern boundary and central parts of the survey areas (Fig. 5.5). George Mukoya Conservancy is located on northern border of Khaudum National Park, adjacent to Muduva Nyangana Conservancy. The Kapinga kaMwalye Conservancy is situated in the Shambyu tribal district and falls into the two political constituencies of Mashare and Rundu Rural in the Kavango East Region. The communal conservancy covers an area of 1301 km² and is situated approximately 20 km east of Rundu.

The southern parts of the targeted survey area are fenced under the communal land use / government resettlement programme (Fig. 5.5). The land uses in the general area is mainly communal / subsistence farming comprising cattle, donkeys and seasonal crop farming which sometimes involves slash and burn practices and clearing of larger tracks of pristine forestry. Subsistence seasonal (January to April) crop farming of sorgam, millet and maize are centred on widely spaced communal villages situated along the Omatako- Omuramba Ephemeral River Channel (Plate 5.2). Outside the Omatako-Omuramba Ephemeral River Channel, forested areas have also been cleared for both agriculture and new settlements with villages centred around communal water points where water is readily available (Plate 5.4).
Figure 5.3: The Transboundary Kavango-Zambezi Transfrontier Conservation Area (KAZA TFCA) initiative and location of the survey area (www.kavangozambezi.org/en/).
Regional map of the Middle Kalahari and the hydrological systems of the Okavango, Kwando, and Zambezi catchments in relation to the sump basins (Lake Ngami, the Mababe Depression and the Makgadikgadi pans). The proposed 2D seismic survey area is not situated in the active catchment areas but in fossil channels of the Omatako–Omuramba Ephemeral rivers. According to Oldeland et al., (2013), the Omatako Ephemeral River has not contributed to runoff from the Okavango for over 50 years.

Figure 5.5: Local land uses around PEL 73 Blocks, Area of Interest (AOI) and the proposed 2D seismic survey areas covering formal proclaimed national parks, community forests, conservancies, agriculture, settlements, and villages.
Plate 5.2: The fossil channel of the now Omatako–Omuramba Ephemeral Channel.
Plate 5.3: The Omatako' Omuramba Ephemeral River channel cleared and fully cultivated for crop production.
Plate 5.4: Forest clearing for settlements and subsistence agriculture commonly found around the proposed survey area.
5.3 Proposed Survey Area Flora, Fauna and Habitats

5.3.1 Desktop Studies

A comprehensive and intensive literature review (i.e., desktop study) regarding the vertebrate fauna (i.e. reptiles, amphibians, mammals and birds) and flora (i.e. trees/shrubs >1m in height and grasses) that could potentially occur in the general area was conducted by a specialist consultant Peter Cunningham, and this was followed by a field based assessment.

5.3.2 Approach to the Field Survey

Fieldwork assessment was conducted in November / December 2020 with updates undertaken in January 2021. The determination of the actual faunal diversity included the following:

- Small mammal transects to determine small mammal diversity in the area.
- Assess larger mammal presence in the area.
- Reptile and amphibian transects to determine reptile and amphibian diversity in the area.
- Bird transects to determine avian diversity in the area.
- Tree/shrub transects to determine diversity in the area, and.
- Grass transects to determine diversity in the area.

Diurnal reptile transects were conducted along various transects throughout the proposed development area and were not conducted in rigid straight lines, but focused on the habitat viewed as most suitable for reptiles. Reptiles observed were either caught by hand or by using an active capture technique called reptile noosing where an extendable fishing rod was fitted with a soft thread noose, positioned over the unsuspecting head of an individual and pulled tight. This technique does not result in the death or injury of the caught specimen. Species caught were identified in situ, photographed and released unharmed at the point of capture.

Amphibians were searched for in areas deemed suitable habitat e.g. drainage lines, pans, etc. with species encountered identified in situ.

Small mammal trapping was conducted by active trapping using collapsible aluminium Sherman traps baited with peanut butter and oats. Traps were set at 3 sites throughout the area with thirty (30) traps used and were placed 20m apart for 3 nights (i.e. potential maximum of 90 captures) within the general area in habitats viewed as potentially suitable for small mammals in the area. Assessing larger mammals from the area was conducted by traversing the area on foot and included actual sightings, tracks, scats and other signs e.g. burrows, scrapes, carcasses, etc.

Bird transects (variable lengths, directions and times) were conducted on foot and by vehicle following permissible tracks throughout the area (when in vehicle) during daylight hours using binoculars to identify and confirm species.

According to the original Terms of Reference (ToR), fieldwork to determine the actual floral diversity was to include the following:

- Trees and shrubs species composition, and.
- Grasses species composition.

Vegetation composition was assessed at various survey sites located between 5 and 10km apart along vehicle tracks along the general seismic survey routes. Seismic survey routes run from north to south and east to west (e.g. NS1/2/3 and EW1/2/3). A rapid assessment of all the trees and shrubs was conducted at each survey site i.e. within a 200m radius of the site. Areas without vehicle access
could not be assessed during this survey. Fieldwork was limited to the accessible areas i.e. along vehicle tracks while other areas without vehicle tracks were not accessible during the fieldwork and thus not surveyed.

5.3.3 Regional Settings

The proposed survey area falls within the Tree Savanna and Woodlands (Northern Kalahari) (Giess 1971) or a combination of North-eastern Kalahari Woodland; Eastern Drainage; Northern Kalahari and Omatako Drainage, with the North-eastern Kalahari Woodland being the dominant vegetation type (Mendelsohn et al. 2002). The vegetation structure is classified as broadleaved woodlands (Mendelsohn et al. 2002). The most important perennial drainage line in the area is the Okavango River (to the north), while the most important ephemeral drainage line is the Omuramba Omatako which meanders down the centre between Blocks 1819 and 1820 (Plates 4.2 and 4.3). The Woodland Biome of which the PEL 73 area forms part of i.e. is not well represented in the protected area network in Namibia of which only 8.4% of the biome is protected (Barnard 1998).

The general area is regarded as medium in overall (all terrestrial species) diversity (Mendelsohn et al. 2002). Overall terrestrial endemism in all species in the area on the other hand is low (Mendelsohn et al. 2002). The overall diversity and abundance of large herbivorous mammals (big game) is viewed as average with oryx, kudu and giraffe dominant especially in areas bordering the National Parks while the overall diversity and density of large carnivorous mammals (large predators) is determined as average with 1-5 species expected e.g. leopard, brown hyena, spotted hyena, cheetah and wild dog (Mendelsohn et al. 2002).

According to Maggs (1998) there are approximately 4344 higher plant species with the most species being within the grasses (422), composites (Asteraceae) (385), legumes (Fabaceae) (377) and fynbos (Mesembryanthemaceae) (177), recorded from Namibia. Total species richness depends on further collecting and taxonomic revisions. High species richness is found in the Okavango, Otavi/Karsveld, Kaokoveld, southern Namib and Central Highland (Windhoek Mountains) areas. Endemic species approximately 687 species in total are mainly associated with the Kaokoveld (north-western) and the succulent Karoo (south-western) Namibia. The major threats to the floral diversity in Namibia are: Conversion of the land to agriculture (with associated problems), and poorly considered development (Maggs 1998, Mendelsohn et al. 2002). A large variety of deciduous trees are found in the Savannah and Woodlands vegetation type. The grasses are usually hard and unpalatable in this area with Anthephora pubescens, Brachiaria nigropedata and Schmidti pappophoroides viewed as the climax grasses in the open savannah areas (Giess 1971). The general area has a medium plant diversity of between 300-399 species although the Okavango River to the north has a higher diversity (400-499 species) (Figs. 5.5 and 5.6). The endemism is viewed as low throughout with no species viewed as endemic (Mendelsohn et al. 2002). Simmons (1998a) puts the plant endemism in the general area at between 1-10 species depending on the locality. These estimates are limited to higher plants as information regarding flower/plants is sparse.

The greatest variants affecting the diversity of plants are habitat and climate with the highest plant diversity generally associated with high rainfall areas. Pockets of high diversity are found throughout Namibia in rûnîquéhabitat often transition zones e.g. mountains, inselbergs, etc. and riparian areas. Furthermore, Mendelsohn et al. (2002) views the overall plant production as very to extremely high while the variation in plant production is mostly very low to low (0-10%) although dependant on the location. The grazing potential is viewed as average to high in the general area while the browse potential is viewed as good. Bush thickening (encroachment) is not viewed as problematic in the general area (Bester 1996, Cunningham 1998). The risk of farming is viewed as high with the tourism potential viewed as average to high (Mendelsohn et al. 2002).

It is estimated that at least 107 species of larger trees and shrubs (>1m in height) and up to 111 species of grasses at least 67 species of reptile, 32 amphibian, 116 mammal and 210 bird species (breeding residents) are known to or expected to occur in the general Kavango East region (Figs. 5.6-5.8).
Figure 5.6: Plant diversity around PEL 73, Areas of Interest (AOI) and the proposed 2D seismic survey lines.
Figure 5.7: Vegetation type around PEL 73, Areas of Interest (AOI) and the proposed 2D seismic survey lines.
Figure 5.8: Bird diversity around PEL 73, Areas of Interest (AOI) and the proposed 2D seismic survey lines.
5.3.4 Fauna Diversity

5.3.4.1 Reptile

Reptile diversity known and/or expected to occur in the general PEL 73 area (literature study only), including species confirmed during the fieldwork as well as the authors confirmed records during other studies from the general area, is presented in Annex 2. Approximately 261 species of reptiles are known or expected to occur in Namibia thus supporting approximately 30% of the continents species diversity (Griffin 1998a). At least 22% or 55 species of Namibian lizards are classified as endemic. The occurrence of reptiles of conservation concern includes about 67% of Namibian reptiles (Griffin 1998a). Emergency grazing and large scale mineral extraction in critical habitats are some of the biggest problems facing reptiles in Namibia (Griffin 1998a).

The overall reptile diversity and endemism in the general area is estimated at between 41-60 species and 1-4 species, respectively (Mendelsohn et al. 2002). Simmons (1998) indicates that 1-6 endemic reptiles are expected from the general area while Griffin (1998a) presents figures of between 1-30 and 41-50 for indigenous lizards and snakes, respectively. The closest Government protected area i.e. Kaudum National Park i.e. has an estimated 66 species of reptiles although no data for Mangetti National Park is included (Griffin 1998a).

At least 67 species of reptiles are expected to occur in the general area with 2 species being endemic i.e. Ichnotropis grandiceps and Lygodactylus bradfieldi (i.e. 3% endemic). Three species are viewed as rare (Lycophidion multimaculatum, Psammophis jallae, Causus rhombeatus); 6 species as vulnerable (Stigmochelys pardalis, Psammobates oculiferus, Kinixys spekii, Python natalensis, Varanus albigatorius, Varanus niloticus); 7 species as protected game (Stigmochelys pardalis, Psammobates oculiferus, Kinixys spekii, Python natalensis, Varanus albigatorius, Varanus niloticus, Crocodylus niloticus); 3 species as insufficiently known (Lycophidion multimaculatum, Psammophis jallae, Causus rhombeatus) and 7 species as peripheral. All the other species are classified as secure. Seventeen species have some form of international conservation status i.e. IUCN (2020) lists 16 species as least concern and 2 species as data deficient i.e. Pelusios (bechuanicus) upembae and Ichnotropis grandiceps (all other species have not yet been assessed by the IUCN Red List); SARDB (2004) lists 4 species as vulnerable and 3 species as peripheral and CITES lists 8 species as C2 i.e. Appendix 2 species. Some species have more than one conservation status.

The 67 species expected to occur in the general area consist of at least 3 tortoises (all vulnerable and protected game), 3 terrapins, 31 snakes (2 blind snakes, 1 thread snake, 1 python, 1 burrowing snake, 1 purple gilled, 1 quill snouted and 24 typical snakes) of which 3 species are classified as rare and 1 species as vulnerable, 5 worm lizards, 8 skinks, 4 old world lizards, 2 plated lizards, 2 monitor lizards, 1 agama, 1 chameleon and 6 geckos and 1 crocodile.

Snakes (31 species), skinks (8 species) and 6 geckos are the most important groups of reptiles expected from the general area.

Namibia with approximately 129 species of lizards (Lacertilia) has one of the continents richest lizard fauna (Griffin 1998a). Geckos expected and/or known to occur in the general area have the highest occurrence of endemics (78.6%) of all the reptiles in this area. Griffin (1998a) confirms the importance of the gecko fauna in Namibia.

During the fieldwork only 2 species were confirmed along the various seismic survey routes assessed (Plates 5.5 and 5.6) and 13 species from the general area i.e. along the Okavango River (e.g. monitor lizards, crocodile) and/or using previous records and publications (e.g. Cunningham and Adank 2005, Visser 2010). This included 3 tortoises, 1 python, 5 typical snakes, 2 Old World lizards, 2 monitors, 1 chameleon and crocodile i.e. a total of at least 14 species are confirmed from the general area (Annex 2). However, species such as the Nile/water monitor and crocodile are exclusively associated with the Okavango River system only i.e. would not occur in the inland areas. The presence of the tortoises, rock monitor and python, are also expected to be tenuous and patchy as they are traditionally collected as veld foods and expected to be extirpated throughout most of the area inhabited by humans. The lack of reptiles observed during the fieldwork would mainly be ascribed to the weather which was overcast with rain showers.
Plate 5.5: Rock or white-throated monitor (Varanus albigularis) observed close to the Okavango River Area (Cunningham, 2021).

Plate 5.6: Cape rough-scaled lizard (Ichnotropis capensis) was observed at two locations in the general awe area along the EW3 seismic route (Cunningham, 2021).
5.3.4.2 Amphibian

Amphibian diversity known and/or expected to occur in the general PEL 73 area (literature study only), including species confirmed during the fieldwork as well as the authors confirmed records during other studies from the general area, is presented in (Annex 2).

Amphibians are declining throughout the world due to various factors of which much has been ascribed to habitat destruction. Basic species lists for various habitats are not always available with Namibia being no exception in this regard while the basic ecology of most species is also unknown. Approximately 4,000 species of amphibians are known worldwide with just over 200 species known from southern Africa and at least 57 species expected to occur in Namibia.

Griffin (1998b) puts this figure at 50 recorded species and a final species richness of approximately 65 species, 6 of which are endemic to Namibia. This flow number of amphibians from Namibia is not only as a result of the generally marginal desert habitat, but also due to Namibia being under studied and under collected. Most amphibians require water to breed and are therefore associated with the permanent water bodies, mainly in northeast Namibia.

According to Mendelsohn et al. (2002), the overall frog diversity in the general area is estimated at between 12-27 species with the latter total associated with the Okavango River. Griffin (1998b) puts the species richness in the general area at 14-29 species.

The closest Government protected area – Kaudum National Park – has an estimated 19 species of amphibians although no data for Mangetti National Park is included (Griffin 1998b). The most important species from the area is viewed as the giant bullfrog (Pyxicephalus adspersus) with populations decreasing according to the IUCN (2020) as it is consumed as food throughout its range (Griffin pers. com.). No endemic species occur in the area (Simmons 1998a).

According to the literature, at least 32 species of amphibians can occur in suitable habitat in the general area although only 17 species potentially occur in the general area. The area is under represented, with 1 tree frog, 1 rain frog, 4 toads, 1 pygmy toad, 2 shovel-nosed toads, 3 reed frogs, 1 kassina, 2 rubber frogs, 3 puddle frogs, 1 ornate frog, 5 grass frogs, 3 platannas, 1 caco, 1 bullfrog and 3 sand frogs known and/or expected (i.e. potentially could be found in the area) to occur in the area. Of these, none are endemic species from the general area.

During the fieldwork no amphibians were observed throughout the general area although there was some open surface water observed in parts of the Omuramba Omatako after localised rain showers (Plate 5.7).

The lack of amphibians observed during the fieldwork would mainly be ascribed to limited time on site; first rains not yet having stimulated much amphibian activity and most of the Omuramba areas having been ploughed and cultivated (Plate 5.8).
Plate 5.7: Water starting to collect in the general Omuramba Omatako area after the first rain showers in the area (Cunningham, 2021).

Plate 5.8: Large parts of the Omaramba Omatako have been cultivated (Cunningham, 2021).
5.3.4.3 Mammals

The overall mammal diversity in the general area is estimated at between 76-90 species with no species being endemic to the area (Mendelsohn et al. 2002). Griffin (1998c) puts the species richness distribution of endemics at 9-11 species in the general area while Simmons (1998a) indicates that no endemics occur in the area.

The closest Government protected area – Kaudum National Park – has an estimated 92 species of mammals although no data for Mangetti National Park is included (Griffin 1998c). According to the literature at least 116 species of mammals are expected to occur in the general area although not all the species (i.e. 11 species) indicated in Table 3 are found away from the Okavango River and associated floodplains e.g. otters, hippo, etc.

Of the species expected to occur in the greater area, 6 species are viewed as rare (Nycteris hispida, Kerivoula argentata, Kerivoula lanosa, Mastomys shortridgei, Civittictis civetta, Paracynictis selousi), 3 endangered (Lycaon pictus, Lutra maculicollis, Equus (burchellii) quagga), 15 vulnerable, 3 specially protected game, 20 protected game, 7 indeterminate, 10 insufficiently known, 4 huntable game, 3 problem animals, 25 peripheral and 12 not listed under Namibian legislation (Griffin and Coetzee 2005).

The IUCN (2020) classifies 1 species as endangered (Lycaon pictus), 7 species as vulnerable (Loxodonta africana, Smutsia (Manis) temminckii, Acinonyx jubatus, Panthera pardus, Panthera leo, Hippopotamus amphibious, Giraffa camelopardalis) and 3 species as near threatened (Hippodintheres vittatus, Aonyx capensis, Hydrictis (Lutra) maculicollis). The SARDB (2004) classifies 2 species as endangered, 5 species as vulnerable, 12 species as near threatened and 7 species as data deficient while CITES lists 2 species as Appendix I and 12 species as Appendix II. Some species have more than one classification. The House Mouse (Mus musculus) is viewed as an invasive alien species to the area. Mus musculus are generally known as casual pests and not viewed as problematic although they are known carriers of "plague" and can cause economic losses (Picker and Griffiths 2011).

Habitat alteration and overutilization are the two primary processes threatening most mammals (Griffin 1998c) with species probably underrepresented for the general area.

At least 31.9% 21.6% and 18.1% of the mammalian fauna that occur or are expected to occur in the general area are represented bats (37 species), carnivores (25 species) and rats and mice (21 species). Habitat alteration and overutilization are the two primary processes threatening most mammals in Namibia (Griffin 1998c). Mammal species probably underrepresented in Table 3 for the general area are bats and rodents, as these groups have not been well documented from the general area.

During the fieldwork only 2 species were confirmed along the various seismic survey routes assessed and 7 species from the general area i.e. along the Okavango River (e.g. otter and hippo) and/or using the author's previous records. This included Damaraland mole-rat, tree squirrel, serval, African clawless otter, slender and banded mongoose, hippo, common duiker and steenbok i.e. a total of at least 9 species are confirmed from the general area (Annex 2).

However, species such as the African clawless otter and hippo are exclusively associated with the Okavango River system only i.e. would not occur in the inland areas.

The presence of larger mammals, are also expected to be tenuous and patchy as they are traditionally hunted as veld foods and expected to be extirpated throughout most of the area inhabited by humans. No small mammals were trapped over three nights with a maximum of 90 potential captures.

The lack of mammals observed during the fieldwork would mainly be ascribed to limited time on site; overcast and rainy weather conditions and overall area habituated with low to dense human presence (Plate 5.9).
Plate 5.9: Human settlements and overall presence affects the presence and abundance of mammals throughout the general area.
At least 210 species of terrestrial [breeding residents] birds occur and/or could occur in the general area. Focus on the general area and excludes birds associated with the Okavango River at any time (Hockey et al. 2006, Maclean 1985, Tarboton 2001).

All the aquatic, extralimital breeders and migrant species have been excluded here. Only one rosy-faced lovebird of the 14 Namibian endemics is expected to occur in the general area. Six species are classified as endangered (hooded vulture, white-backed vulture, tawny eagle, martial eagle, bateleur, southern ground-hornbill), 3 species as vulnerable (secretarybird, white-headed vulture, lappet-faced vulture) and 3 species as near threatened (marabou stork, peregrine falcon, kori bustard) from Namibia (Simmons et al. 2015).

The IUCN (2020) classifies 3 species as critically endangered (hooded vulture, white-headed vulture, white-backed vulture), 1 species as endangered (lappet-faced vulture), 4 species as vulnerable (secretarybird, tawny eagle, martial eagle, southern ground-hornbill) and 2 species as near threatened (bateleur, kori bustard).

Twenty-seven species (12.9% of all the birds expected) have a southern African conservation rating with 2 species classified as endemic (7.4% of southern African endemics or 1% of all the birds expected) and 25 species classified as near endemic (92.6% of southern African endemics or 11.9% of all the birds expected) (Hockey et al. 2006).

Many species expected to occur in the general area are migratory e.g. bustards and korhaan and not found permanently in the area. Other species may frequent the area only if water collects in the Omuramba Omatako or whilst moving between wetlands in Etosha and Bushmanland e.g. cranes, ducks, flamingo, etc. As very little ringing/recording occurs in this part of Namibia, little is known about the distribution and ecology of many species from the general area with many more species expected to occur.

During the fieldwork only 44 species were confirmed along the various seismic survey routes assessed of which 7 species are not included in the Annex 2 as these are migratory or out of range species (i.e. barn swallow, red-billed oxpecker, yellow-billed kite, trac-trac chat, steppe buzzard, red-footed falcon) and another 40 species from the general area i.e. along the Okavango River and/or using the specialist consultant previous records (Annex 2).

However, many other aquatic species would be associated with the Okavango River, but not included here i.e. would not normally occur in the inland areas.

The Omuramba Omatako may attract aquatic species in inland areas when water collects after rain showers. However, large areas of this Omuramba have now been ploughed for fields and altered by humans for subsistence farming degrading this once important habitat (Plates 5.10 and 5.11).
Plate 5.10: Large parts of the Omuramba Omatako have been altered by humans for farming purposes and have consequently become degraded as an aquatic avifauna habitat (Cunningham, 2021).

Plate 5.11: Fields are fenced and ploughed within the Omaramba Omatako (Cunningham, 2021).
5.3.5 Flora Diversity

5.3.5.1 Tree and Shrub

The tree and shrub diversity known and/or expected to occur in the general PEL 73 area (literature study only), including species confirmed during the fieldwork as well as the authors confirmed records during other studies from the general area, is presented in Table 5.1 and Annex 2. Table 5.1 indicates tree and shrub diversity expected and confirmed during the fieldwork at each of the 24 vegetation survey points conducted.

At least 107 species of larger trees/shrubs are expected to occur in the general area of which none are viewed as endemics. Eighteen species (16.8%) are protected by the Forest Act No. 12 of 2001 while 1 species is protected by the Nature Conservation Ordinance No. 4 of 1975 (0.9%) (Mannheimer and Curtis 2018).

Three species are classified as Lower Risk (Near Threatened) (2.8%) (Loots 2005). Species with the most diversity expected from the general area are Combretum (10 species) and Grewia (10 species) followed by Acacia (8 species).

During the fieldwork a total of 43 larger trees and shrubs was confirmed from the various seismic routes with the NS1 (32 spp.) and EW2 (11 spp.) routes having the highest and lowest number of species, respectively (Annex 2).

Of these 43 species, 12 species are protected by the Forest Act No12. of 2001 i.e. 27.9%. The actual vegetation survey points varied between 4 and 16 species, respectively (Annex 2 and Plates 5.12-5.17).
Table 5.1: Tree and shrub diversity expected and confirmed during the fieldwork at each of the 24 vegetation survey points conducted. NS and EW = Seismic survey routes from north to south and east to west (Cunningham, 2021).

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<thead>
<tr>
<th>Species: Scientific name</th>
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<tr>
<td>Acacia hebeclada</td>
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<td></td>
</tr>
<tr>
<td>Acacia luederitzii</td>
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<td></td>
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<tr>
<td>Acacia mellifera</td>
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<td></td>
</tr>
<tr>
<td>Acacia tortilis</td>
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</tr>
<tr>
<td>Adansonia digitata</td>
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</tr>
<tr>
<td>Albizia anthelmintica</td>
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<td></td>
</tr>
<tr>
<td>Albizia antunesiana</td>
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<td>Albizia harveyi</td>
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<td></td>
</tr>
<tr>
<td>Aloe litoralis</td>
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</tr>
<tr>
<td>Annona stenophylla</td>
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<td></td>
</tr>
<tr>
<td>Baikiaea plurijuga</td>
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<tr>
<td>Baissea wulfhorstii</td>
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<td></td>
</tr>
<tr>
<td>Baphia massaiensis</td>
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</tr>
<tr>
<td>Bauhinia petersiana</td>
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<td></td>
</tr>
<tr>
<td>Bauhinia urbaniana</td>
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</tr>
<tr>
<td>Boscia albitrunca</td>
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</tr>
</tbody>
</table>

F# – Forest Act No. 12 of 2001
NC – Nature Conservation Ordinance No. 4 of 1975
C2 – CITES Appendix 2 (Mannheimer and Curtis 2018)
LR-nt – lower risk, near threatened (Loots 2005)
\Δ – Dominant species

Important areas: KNP = Kaudum NP access route/narrow sandy track/relatively pristine area; O = Omuramba; OO = Omaramba Omatako; Pan = Small pans with Combretum imberbe
### Table 5.1: Cont.

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<tr>
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</tr>
<tr>
<td>Combretum engleri</td>
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<td></td>
</tr>
<tr>
<td>Combretum hereroense</td>
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<td></td>
</tr>
<tr>
<td>Combretum mosambicense</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combretum imberbe</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Combretum platypetalum</td>
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</tr>
<tr>
<td>Combretum psidioides</td>
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<td></td>
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<td>Combretum zeyheri</td>
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<td></td>
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<td>Commiphora africana</td>
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<td>Commiphora angolensis</td>
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</tr>
<tr>
<td>Commiphora tenuepitolata</td>
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<td></td>
</tr>
</tbody>
</table>

**Important areas:** KNP = Kaudum NP access route/narrow sandy track/relatively pristine area; O = Omuramba; OO = Omaramba Omatako; Pan = Small pans with *Combretum imberbe*

**Invasive alien species:** Euc = *Eucalyptus* spp.; O = *Opuntia* spp.; S = *Sisal* spp. **Source for literature review:** Mannheimer and Curtis (2018) 

**Footnotes:**
- F# Forest Act No. 12 of 2001
- NC Nature Conservation Ordinance No. 4 of 1975
- C2 CITES Appendix 2 (Mannheimer and Curtis 2018)
- LR-nt lower risk, near threatened (Loots 2005)
- Δ Dominant species
Table 5.1: Cont.

| Species: Scientific name       | NS1 | NS1 | NS1 | NS1 | NS1 | NS1 | NS2 | NS2 | NS3 | NS3 | EW1 | EW1 | EW1 | EW1 | EW1 | EW2 | EW2 | EW2 | EW3 | EW3 |
|--------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Cordia sinensis                |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Croton gratissimus             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Croton menyharthii             | a   | a   | a   | a   | a   | a   | a   | a   | a   | a   | Protected (F#) |
| Dialium engleranum             |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Dichrostachys cinerea          |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Diospyros chamaethamnus        |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Diospyros lycioides            |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Diplorhynchus condylocarpon    |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Ehretia alba                   |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Elaeodendron transvaalense     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Entada arenaria                |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Erythrococca menyharthii       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Erythrophleum africanum        |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Euclea divinorum               |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Flueggea virosa                |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Ficus burkii/F. petersii       |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Grewia avellana                |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
| Grewia bicolor                 |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |

**Namibian conservation and legal status**

- **F#** - Forest Act No. 12 of 2001
- **NC** - Nature Conservation Ordinance No. 4 of 1975
- **C2** - CITES Appendix 2 (Mannheimer and Curtis 2018)
- **LR-nt** - lower risk, near threatened (Loots 2005)
- **Δ** - Dominant species

**Important areas:** KNP = Kaudum NP access route/narrow sandy track/relatively pristine area; O = Omuramba; OO = Omaramba Omatako; Pan = Small pans with Combretum imberbe

**Invasive alien species:** Euc = Eucalyptus spp.; O = Opuntia spp.; S = Sisal spp. **Source for literature review:** Mannheimer and Curtis (2018)
Table 5.1: Cont.

<table>
<thead>
<tr>
<th>Species: Scientific name</th>
<th>Species confirmed</th>
<th>Namibian conservation and legal status</th>
</tr>
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<tbody>
<tr>
<td>Grewia falciptipula</td>
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</tr>
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</tr>
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<td>å</td>
</tr>
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</tr>
<tr>
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<td>å</td>
</tr>
<tr>
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<tr>
<td>Guibourtia coleosperma</td>
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</tr>
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Dominant species: Grewia flavescens, Gymnosporia senegalensis, Guibourtia coleosperma

Important areas: KNP = Kaudum NP access route/narrow sandy track/relatively pristine area; O = Omuramba; OO = Omaramba Omatak; Pan = Small pans with Combretum imberbe

Invasive alien species: Euc = Eucalyptus spp.; O = Opuntia spp.; S = Sisal spp.

Source for literature review: Mannheimer and Curtis (2018)

Forest Act No. 12 of 2001
Nature Conservation Ordinance No. 4 of 1975
CITES Appendix 2 (Mannheimer and Curtis 2018)
Lower risk, near threatened (Loots 2005)
Lower risk, near threatened (Loots 2005)
Table 5.1: Cont.

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F# Forest Act No. 12 of 2001
NC Nature Conservation Ordinance No. 4 of 1975
C² CITES Appendix 2 (Mannheimer and Curtis 2018)
LR-nt lower risk, near threatened (Loots 2005)
△ Dominant species

Important areas: KNP = Kaudum NP access route/narrow sandy track/relatively pristine area; O = Omuramba; OO = Omaramba Omatako; Pan = Small pans with Combretum imberbe
Table 5.1: Cont.

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| Total number of species:         |                       |                                        |
| Important areas:                 |                       |                                        |
| Invasive alien species:          |                       |                                        |
| Wildlife tracks:                 |                       |                                        |

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<th>NS1</th>
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</tbody>
</table>

| Source for literature review:    | Mannheimer and Curtis (2018) |

---

F# | Forest Act No. 12 of 2001
NC | Nature Conservation Ordinance No. 4 of 1975
C2 | CITES Appendix 2 (Mannheimer and Curtis 2018)
LR-nt | lower risk, near threatened (Loots 2005)
\*A | Dominant species

Important areas: KNP = Kaudum NP access route/narrow sandy track/relatively pristine area; O = Omuramba; OO = Omaramba Omatako; Pan = Small pans with Combretum imberbe

Invasive alien species: Euc = Eucalyptus spp.; O = Opuntia spp.; S = Sisal spp.

Source for literature review: Mannheimer and Curtis (2018)
Plate 5.12: *Baikiaea plurijuga* (Zambezi teak – Near Threatened, IUCN 2020) is protected and has been targeted extensively for illegal logging purposes (Cunningham, 2021).
Plate 5.13: *Burkea africana* (burkea) are some of the taller trees in the area and are targeted for timber and firewood production (Cunningham, 2021).
Plate 5.14: *Guibourtia coleosperma* (false mopane) is protected and is a valuable fruit tree in the area (Cunningham, 2021).
Plate 5.15: *Pterocarpus angolensis* (kiaat) have been heavily utilised in the past for timber production (Cunningham, 2021).
Plate 5.16: *Schinziophyton rautanenii* (manketti) is a protected and valuable fruit tree in the area (Cunningham, 2021).
Plate 5.17: *Strychnos* species (monkey orange spp.) — protected — are valuable fruit trees throughout the area (Cunningham, 2021).
5.3.5.2 Grass

The grass diversity known and/or expected to occur in the general PEL 73 area (literature study only), including species confirmed during the fieldwork as well as the authors confirmed records during other studies from the general area, is presented in Annex 2 detailing grass diversity along the various seismic routes. It is estimated that at least 18-96 grasses (Müller 1984 [18sp.], Müller 2007 [43sp.], Van Oudshoorn 1999 [96sp.]) yield an approximate total of 111 species that occur in the general PEL 73 area.

The grasses known and/or expected to occur in the general area (1Müller 2007, 2Van Oudtshoorn 1999 and 3Müller 1984) is presented in Annex 2. Although up to 111 grasses are expected to occur in the general area, none of the 4 species of grasses endemic to Namibia is expected in the area (Müller 2007).

Except for the general ecological role of grasses (e.g. stabilising the soil, fodder/ grazing value, etc.) none of the grasses are viewed as exceptionally unique in the area. The grasses commonly used for thatching i.e. Eragrostis pallens and Cymbopogon species i.e. which also have economic value, are the important grasses in the area.

During the fieldwork a total of 11 grasses were confirmed from the various seismic routes with the NS1 (10 spp.) and EW1 (6 spp.) routes having the highest number of species, respectively (Annex 2). Few grass species were confirmed from the area due to the rains having just started; large areas having been burnt and heavy grazing (overgrazing in places) pressure throughout (Plate 5.18).

5.3.5.3 Other Flora species

Of the 27 Aloe species known from Namibia at least 2 other species Aloe hereroensis and A. zebrina i.e. occur on the periphery of the general area and may occur in the PEL 73 area (Rothman 2004). No Aloe spp. was observed throughout the area during the fieldwork.

Although many Commiphora species potentially occur throughout the area (Steyn 2003) some species i.e. e.g. C. wildii i.e. have economic potential (i.e. resin properties used in the perfume industry) i.e. making them potentially important (Knott and Curtis 2006). Other species potentially occurring in the general area (e.g. northeast i.e. Okavango River. Few other types of Commiphora spp. were observed during the fieldwork (Annex 2).

At least 64 species of ferns, of which 13 species being endemic, occur throughout Namibia. Ferns in the general area i.e. include at least 1 endemic species (Marsilea vilifolia) and at least 6 indigenous species (Isoetes alstonii, Marsilea ephippiocarpa, M. macrocarpa, M. nubica, M. vera, Ophioglossum polyphyllum) (Crouch et al. 2011). The general area is undercollected with more species probably occurring in the area than presented above. No fern spp. was observed throughout the area during the fieldwork.

No lichen spp. was observed throughout the area during the fieldwork. Other species with commercial potential that could occur in the general area include Citrullus lanatus (Tsamma melon) and Harpagophytum procumbens (devil’s claw) which potentially have a huge economic benefit (Mendelsohn et al. 2002).

Invasive alien species were observed during the fieldwork (Annex 2) included: Eucalyptus spp. (Plate 5.19) Opuntia spp. (Plate 4.20) Sisal spp. These species were usually associated with human settlements throughout the area i.e. along sections of the NS1 and EW1 seismic survey routes (Annex 2).
Large herds of cattle and a continuous grazing system have resulted in large areas being denuded of grass and/or, together with unseasonal fires, impacted on the species diversity over time (Insert Photo: Peter Cunningham).
Plate 5.19: *Eucalyptus* spp. (blue gum spp. See arrows) is an invasive alien plant species to Namibia and should be eradicated when encountered away from human settlements (Cunningham, 2021).

Plate 5.20: *Opuntia* spp. (prickly pear spp.) is an invasive alien plant species to Namibia and readily spread by birds and other mammals feeding on the palatable fruit. These should be eradicated when encountered away from human settlements (Cunningham, 2021).
5.4 Summary of the Socioeconomic Settings

5.4.1 Overview

The socio-economic profile of affected area was compiled based on the accessibility and availability of secondary data sources. A comprehensive literature review was conducted between 16th December 2020 and 15th February 2021 and is largely based on existing documentation published by both the public and private sectors.

The majority of statistical data was obtained with the guidance of the 2011 Population and Housing Census, Kavango West and Kavango East Regional Tables Based on 4th Delimitation, Namibia Intercensal Demographic Survey 2016 Report, Namibia Labour Force Survey 2016 Report and Baseline Reports for Integrated Land Use Planning in Kavango East and Kavango West regions.

The national Census was completed for Kavango Region in 2011. In 2013, with the recommendations by the 4th Delimitation Committee, the Kavango Region was split into the Kavango West and the Kavango East regions. Likewise the changes occurred at the constituency level. For example, the Ncamangoro Constituency was created in 2013, with the separation from a larger Kapako Constituency.

The census data at the time was collected without distinguishing the Ncamangoro Constituency. The borders of Mashare Constituency has been adjusted since. Nevertheless, the obtained data and information is sufficient to guide and embody the project proponent as the Namibia Inter-censal Demographic Survey occurred in 2016.

The PEL 73 covering Blocks 1718 and 1818 is situated in the Kavango West and Kavango East Region in northern Namibia. The greater parts of the license area are general sparsely populated with much of the population concentrated along the Okavango River marking the border between Namibia and Angola. PEL 73 and the proposed 2D seismic survey area covers parts of both the Kavango West and East Regions in northern Namibia.

Kavango West Region covers an area of 24,591.27 km² and lies directly south of Angola and the Kavango River and east of Ohangwena and Oshikoto Regions, north of Otjozondjupa Region and west of the Kavango East Region. The boundary between Kavango East and West generally follows the Omatako-Omuramba River. Kavango East Region covers an area of 23,987 km² and is bordered by the Kavango West, Otjozondjupa and Zambezi Regions.

The main economic activities of the Kavango West and East Regions are agriculture, mainly small-scale mahangu farming, providing some food self-sufficiency but little food security; aquaculture; timber harvesting; tourism, particularly in Kavango East Region; and sand mining activities. Livelihoods are thus considerably diversified, with residents relying also on wages and salaries, pensions and cash remittances.

5.4.2 Social Environment

5.4.2.1 Population Profile–Size, Structure and Composition

The socioeconomic profile of the project has been compiled by Stankevica (2021). The area of interest falls within the sparsely populated but not pristine communal areas of two Kavango Regions i.e. Kavango East and Kavango West with total area of 48,584.27 km². It is home to 237,779 people (NSA, 2017a) which is 16.6% of total Namibian population. According to the 2011 Population and Housing Census data, Kavango West Tables that are based on 4th Delimitation, and data provided by the Kavango East Regional Council, the following is the population size of constituencies that are located in the area of interest (Table 5.2).

According to the 2016 inter-census data (NSA, 2017a) there are 148,466 people in Kavango East Region making 3.8% of total population of Namibia and 89,313 people in Kavango West making 6.4% of total population of Namibia. In a period between Census 2011 and inter-census 2016 the growth rate of population is positive, yet at a slow pace, particularly for Kavango West Region. The growth
rate for Kavango East was 1.6% and Kavango West 0.6%. Kavango East has the lowest growth rates following after Omusati Region (0.5%) (NSA, 2017a).

Table 5.2: Population size by area (Source of data: NSA, 2014a, KERC, n.d.).

<table>
<thead>
<tr>
<th>Region</th>
<th>Constituency</th>
<th>Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kavango East</td>
<td>Ndiyona</td>
<td>9551</td>
</tr>
<tr>
<td>Kavango East</td>
<td>Ndonga Linena</td>
<td>11082</td>
</tr>
<tr>
<td>Kavango East</td>
<td>Mashare</td>
<td>15688</td>
</tr>
<tr>
<td>Kavango East</td>
<td>Rundu Rural</td>
<td>9381</td>
</tr>
<tr>
<td>Kavango West</td>
<td>Ncuncuni</td>
<td>8541</td>
</tr>
<tr>
<td>Kavango West</td>
<td>Ncamagarlo</td>
<td>7046</td>
</tr>
</tbody>
</table>

2011 Census (NSA, 2014a&b) and 2016 Inter-Census data (NSA, 2017a) revealed that female population is larger than male population in both regions (Fig. 5.9). In 2011 Kavango East Region had 53.3% females and Kavango West 52.8%. In 2016 the percentages of female population were very similar to 2011 data (Kavango East Region - 53.5% and Kavango West ï’ 52.7%). However, between 2011 and 2016, Kavango West experienced an insignificant 0.1% drop and Kavango East experienced 0.2% growth of female population (Fig. 5.9).

At the constituency level, the population distribution by gender and area is as per Table 5.3. Kavango East constituencies had larger percentage of female population than Kavango West constituencies. The population of Kavango regions was very youthful, around 41.4% of people in Kavango East and 46.5% of people in Kavango West were youth from 0 to 14 years (Fig. 5.10). The national average for this age group was 36.4% (NSA, 2017a). It is characteristic to Namibia to have larger proportion of youth, particularly in age group of 15-24 years old. The percentage of this age group (15-59 years) for Namibia was 57.3%. Kavango East census data presented 52.7% and Kavango West 47.2% of people in working-age group (15-59 years).
Table 5.3: Population distribution by sex and area (NSA, 2014a and KERC, n.d.).

<table>
<thead>
<tr>
<th>Region</th>
<th>Constituency</th>
<th>Female</th>
<th>Percentage (%) of female</th>
<th>Male</th>
<th>Percentage (%) of male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kavango East</td>
<td>Ndiyona</td>
<td>5122</td>
<td>54</td>
<td>4429</td>
<td>46</td>
</tr>
<tr>
<td>Kavango East</td>
<td>Ndonga Linena</td>
<td>6013</td>
<td>54</td>
<td>5069</td>
<td>46</td>
</tr>
<tr>
<td>Kavango East</td>
<td>Mashare</td>
<td>8234</td>
<td>52</td>
<td>7454</td>
<td>48</td>
</tr>
<tr>
<td>Kavango East</td>
<td>Rundu Rural</td>
<td>4955</td>
<td>53</td>
<td>4426</td>
<td>47</td>
</tr>
<tr>
<td>Kavango West</td>
<td>Ncuncuni</td>
<td>4455</td>
<td>52</td>
<td>4086</td>
<td>48</td>
</tr>
<tr>
<td>Kavango West</td>
<td>Ncamagaro</td>
<td>3654</td>
<td>52</td>
<td>3389</td>
<td>48</td>
</tr>
</tbody>
</table>

![Population age profile of Kavango East and Kavango West Regions, 2016](source)

Kavango teenage pregnancy rate is the highest in the country. The average for Namibia was 87.2% (NSA, 2014c). These could have negative impact on the health of the adolescents and their infants. It also contributes to a high level of poverty, illiteracy, and a low level of education and thus a poor quality of life. The female teens in age group 15-19 who has never given a birth were only 76.5%.

Mortality is one of the factors that affect the population size, age, and sex distribution. Table 5.4 presents the number of reported deaths in the last 12 months by sex and area. The results show that a total of 2509 deaths has occurred during the last 12 months prior to the survey in in Kavango East and a total of 1535 death in Kavango West (2011 Census mortality Report).

Table 5.4: Number of reported deaths in the last 12 months by sex and area (Source of data: NSA, 2017a).

<table>
<thead>
<tr>
<th>Area</th>
<th>Total</th>
<th>Female</th>
<th>Male</th>
</tr>
</thead>
<tbody>
<tr>
<td>Namibia</td>
<td>25096</td>
<td>11609</td>
<td>13487</td>
</tr>
<tr>
<td>Kavango East</td>
<td>2509</td>
<td>1417</td>
<td>1092</td>
</tr>
<tr>
<td>Kavango West</td>
<td>1535</td>
<td>695</td>
<td>840</td>
</tr>
</tbody>
</table>

2011 census data revealed that Kavango Region had highest crude death rate (CDR) of 14.6 while national average was 10.7. Kavango Region also had the highest child mortality rates <5 (CMR) in the country. While for Namibia it was 69 deaths per 1000 live births, Kavango regions had 112 deaths per 1000 live births (NSA, 2014d).

Kavango Regions had the lowest life expectancy in Namibia. In Namibia the life expectancy for male was 53.3 years and 60.5 for female. In Kavango regions the life expectancy for male was 43.9 years and 52.8 years for female (NSA, 2014d).
Inter-census recorded that both Kavango Regions had high proportion of persons with disabilities, particularly high percentage was in Kavango West (7.6%). This was the highest in Namibia, followed by Ohangwena (6.8%). Kavango East recorded 6.0% of persons with disabilities. Average for Namibia is 4.7% (NSA, 2017a).

Kavango regions scored high on percent distribution of orphans aged 18 years and below. The inter-census had recorded highest levels of orphanhood in Zambezi Region with 16.6 percent and followed by Kavango East with 15.9% of orphaned children. Kavango West recorded 14% of children who were orphaned. The national average stood at 12.5% (NSA, 2017a).

Kavango West region had the highest percentage of population without birth certificate (32.2%) followed by Kavango East with 19.9%. Birth certificates provide proof of identity and it is essential to obtain it as it facilitates accessing of social services, such as social grants and educational services (NSA, 2014c).

Regarding the population density that shows the relationship between the population and the size of the area there was a slight difference between Kavango West and Kavango East regions. In 2016 the population density was 6.2 people per km\(^2\) in Kavango East and 3.6 people per km\(^2\) in Kavango West Region. This is above the population density for Namibia which stands at 2.8 people per km\(^2\) (NSA, 2017a). Thus the population density in both regions was above national average and steadily increasing from 2011 to 2016 (Fig. 5.11). Kavango East had larger increase than Kavango West. Kavango East was among the most densely populated areas in Namibia.

![Figure 5.11: Population densities (persons per km\(^2\)) of Kavango East and Kavango West Regions in 2011 and 2016 (Source of data: NSA, 2017a).](image)

At the constituency level the population density was as per Table 5.5, clearly presenting that Rundu Rural and Ncuncuni constituencies were the most densely populated areas within the area of interest, respectively 8.8 and 6.1 person per km\(^2\).

On the other hand, Ncamagoro was the least densely populated constituency with a density of 1.4 persons per square kilometre followed by Mashare and Ndiyona constituencies each with 1.7 and 1.8 people per square kilometre respectively.

There was a noticeable movement of people from rural to urban areas. The long-term migration for both Kavango regions together was negative. There were more people leaving the area than coming in (Fig. 5.12).
Table 5.5: Population density by area (people per km²) (Source of data: NSA, 2014a, KERC, n.d.).

<table>
<thead>
<tr>
<th>Region</th>
<th>Constituency</th>
<th>Population density</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kavango East</td>
<td>Ndiyona</td>
<td>1.8</td>
</tr>
<tr>
<td>Kavango East</td>
<td>Ndonga Linena</td>
<td>3.9</td>
</tr>
<tr>
<td>Kavango East</td>
<td>Mashare</td>
<td>1.7</td>
</tr>
<tr>
<td>Kavango East</td>
<td>Rundu Rural</td>
<td>8.8</td>
</tr>
<tr>
<td>Kavango West</td>
<td>Ncuncuni</td>
<td>6.1</td>
</tr>
<tr>
<td>Kavango West</td>
<td>Ncamagaro</td>
<td>1.4</td>
</tr>
</tbody>
</table>

Figure 5.12: Long-term migration for both Kavango Regions (Source of data: NSA, 2014e).

The overall Kavango Regional urban/ rural rate for 2011 is used to show that the majority of the people in the two regions were still living in the rural areas (71%) on Communal land (NSA, 2014a). Although communal land is owned by the State under the Communal Land Reform Act, the Act also makes provision for Traditional Authorities to have a certain degree of control over the communal land within their jurisdiction.

Within the area of interest there are following tribal (traditional) authorities - Shambyu, Gciruku and Mbukushu in the Kavango East, and Kwangali and M bunza tribal (traditional) authorities in the Kavango West Region.

Traditional authority leadership in the Kavango regions consists of chiefs (hompa/fumu), senior headmen, headmen and community leaders. A chief /hompa/ fumu is usually a member of the royal family that will be appointed by the current chief/hompa. The headman has the responsibility for several communities or villages and they are elected by community members where after the chief then ratify their appointment. Tribal areas are divided into wards, each of which is headed by a senior headman who is appointed by the Chief (MLR, 2015a and Mendelsohn, 2009).

Rukavango-speaking people constituted by far the largest language group in Kavango (79.4% of the population), and San constituted around 0.4% of the regions' population (NSA, 2014a).

According to Thiem & Jones (2014) there were groups of San living in and around urban areas such as Rundu and Nkurenkuru; and other groups lived in small villages of their own, and in small numbers around many villages inhabited mainly by Kavango people.
The !Xun was reported of being the main San group in Kavango Region, and lived mainly in the south-west of the region around the Mpunguveld. Other groups lived in small villages east of Rundu across to Andara. In addition to the !Xun, small numbers of Hai¡om and Khwe San lived scattered throughout both Kavango regions, and small numbers of Ju|’hoansi lived near Khaudum and Samagaigai. Other San groups in the region included the Khwe and !Xun communities living within the Bwabwata National Park (Thiem and Jones, 2014).

Within the area of interest there is Likwaterera village located in the Rundu Rural Constituency, about 40 km south-east of Rundu along a gravel road going south just beyond the Rundu municipal boundary and that is mainly populated by Shambyu people. Thiem & Jones (2014) reported that in 2010, 140-160 San people were moved to this village: 12 San families came from Mazana village and 8 families came from Kamboho village; the number of people per household ranged from 4 to 16. The San of Likwaterera were living in a 20 ha compound which had been fenced off to keep their livestock within the compound i.e. to prevent them from wandering into neighbouring fields. The San at this site were dependent mainly on piecework and old age pensions for cash. A few people cultivated fields, but most were dependent on government food aid and purchasing or bartering for mahangu or mealie-meal. Gathering veldfood was important when there was insufficient food in a household and few opportunities to earn cash.

Rundu Ndama is another small peri-urban neighbourhood, located on the outskirts of the town of Rundu in Rundu Rural Constituency where a group of San (!Xun) were living together other ethnic groups. The Shambyu traditional authority had given the !Xun of Ndama permission to stay there, and allegedly the Rundu Town Council had allocated land to them. Subsequently the !Xun had allowed non-San people to move in and settle there too. The !Xun in Ndama derived their livelihoods mainly from the old age pension, veldfood and piecework. They had comparatively more opportunities than San in other areas of Kavango to find piecework due to their close proximity to the town of Rundu. In addition they sold fire wood and crafts (e.g. bows and arrows, baskets etc.). Most of the !Xun in Ndama had moved there from other places in Kavango (Thiem and Jones, 2014).

Despite being scattered among other ethnic groups and rarely forming the majority, the San had preserved a strong sense of cultural and ethnic identity. San group can be identified by their language and physical characteristics.

The San are among the poorest people in Kavango Region, but it has to be noted there are many very poor people among other ethnic groups in Kavango (NPC, 2007).

5.4.2.2 Socio-economic Characteristics of Population

The literacy rates present the data on the ability to read and write with understanding in any language for the population aged 15 years and above.

The Namibia Household Income and Expenditure Survey (NHIES) 2015/2016 revealed that 87.4% of Namibian population are literate (NSA, 2017c). Nevertheless, the literacy rate for the Kavango East and Kavango West Regions is well below the national level. In 2011 Census Kavango East literacy rate was 74.4% and Kavango West 77.3% (NSA, 2014) and male being slightly more literate than female. The data indicates that literacy rate of both Kavango regions was low in comparison to Khomas Region (96.7%), which had the highest literacy rate in Namibia.

According to the NHIES 2015/2016 report there was a slight improvement. The results revealed that male literacy rate for Kavango East Region was 82.3% and Kavango West 82.9% (NSA, 2017c). Female literacy rates stood at 73.6% for Kavango East and 77.9% for Kavango West. This was a literacy rate for the population 15 years and above, but literacy rate for young people (15-24 years) was considerably higher. Male (15-24 years) literacy rate for Kavango East i.e 91% and Kavango West i.e 97.9%, but female (15-24 years) rate for Kavango East - 93% and Kavango West - 95.6%.

Over 42% of Kavango East children that were over the age of 15 have left school while 17% of children over the age of 15 years had never attended school, which was much higher percentage than the
national average - 13%. In Kavango West more than 58% of children over the age of 15 left school while 21% of children over the age of 15 years have never attended school (NSA, 2014b).

At the constituency level, adult literacy rate is presented in Table 5.6.

Table 5.6: Literacy rate (%) for population 15 years and above by sex and constituency (Source of data: NSA, 2014a&b, KERC, n.d.).

<table>
<thead>
<tr>
<th>Region</th>
<th>Constituency</th>
<th>Female</th>
<th>Male</th>
<th>Both sexes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kavango East</td>
<td>Ndiyona</td>
<td>73.7</td>
<td>84.7</td>
<td>78.5</td>
</tr>
<tr>
<td>Kavango East</td>
<td>Ndonga Linena</td>
<td>72.5</td>
<td>82.8</td>
<td>76.9</td>
</tr>
<tr>
<td>Kavango East</td>
<td>Mashare</td>
<td>67.2</td>
<td>79</td>
<td>72</td>
</tr>
<tr>
<td>Kavango East</td>
<td>Rundu Rural</td>
<td>66.7</td>
<td>78.8</td>
<td>72</td>
</tr>
<tr>
<td>Kavango West</td>
<td>Ncuncuni</td>
<td>66.4</td>
<td>77</td>
<td>71.4</td>
</tr>
<tr>
<td>Kavango West</td>
<td>Ncamagaro</td>
<td>61</td>
<td>66</td>
<td>63.3</td>
</tr>
</tbody>
</table>

The data on regional unemployment rate in Namibia revealed that the highest rate of unemployment was in Kavango East (48.2%) followed by Omaheke (38.7%). Unemployment rate for Namibia was 33.4% (NSA, 2019).

Furthermore, the unemployment rate was slightly higher for females than males in both regions (Fig. 5.13).

![Unemployment rate by sex and region](image)

Figure 5.13: Unemployment rate by sex and region (Source of data: NSA, 2019).

The unemployment rate is widely regarded as one of the key labour market indicators and a good measure for employment creation and participation in economic activities in the country (NSA, 2017b). A lower unemployment rate signifies a growing economy, while a higher rates signifies a declining economy and its inability to absorb people of working age.

Unemployment rate for youth aged 15 to 34 by region and sex is presented in the Table 5.7.

Table 5.7: Unemployment rate (%) for youth aged 15 to 34 years by region and sex (Source of data: NSA, 2019).

<table>
<thead>
<tr>
<th>Area</th>
<th>Both sexes</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Namibia</td>
<td>46.1</td>
<td>43.7</td>
<td>48.5</td>
</tr>
<tr>
<td>Kavango East</td>
<td>62.5</td>
<td>62</td>
<td>62.9</td>
</tr>
<tr>
<td>Kavango West</td>
<td>46.8</td>
<td>44.6</td>
<td>48.4</td>
</tr>
</tbody>
</table>
The data for youth unemployment reveals that youth unemployment is particularly severe in Kavango East Region where more than half of youth (62.5%) are unemployed (Fig. 5.14). This is highest youth unemployment rate in Namibia.

![Unemployment rate for youth 15 to 34 years (Source of data: NSA, 2019).](image)

The Namibia Labour Force Survey 2018 revealed that the employment rates had deteriorated even further since national census in 2011. In 2011 the unemployment rate in Kavango East was 39.6% and 36.4 % in Kavango West (NSA, 2014b).

The large unemployment rate can be attributed to the limited formal employment within the region as the majority of households still obtain income from subsistence activities. Lack of employment may lead to the high migration rate to other regions, particularly for men.

Kavango West Region has the highest percentage of informal employments (91.8%), followed by Kavango East (78.8%). Whereas the region with the lowest percentage of employees in informal employments is Erongo with 55.3 % (NSA, 2017b).

The main employment industries in Kavango East and Kavango West were agriculture, forestry and fisheries. Around 45.95% of employed in Kavango East are in the agriculture, forestry and fisheries sector. In Kavango West the share is even larger - 80.04% (MLR, 2015a&b).

In Kavango West Region 63% of the farming population practiced crop production, 28% were involved in livestock rearing and the much less practiced farming activities such as poultry (7%), agro-processing (2%) and both horticulture and others are at (0%) as depicted in Fig. 5.15.

![Percentage distribution of farming population by type of agricultural activity in Kavango West Region (Source of data: NSA, 2014b).](image)
The main occupations of the employed population (in Kavango East and Kavango West Regions) is reflected in Table 5.8.

Table 5.8: Main occupation of the employed population (in percentage) within Kavango East and Kavango West Regions (Source of data: NSA, 2014a&b).

<table>
<thead>
<tr>
<th></th>
<th>Kavango East Region</th>
<th>Kavango West Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>Armed forces</td>
<td>4.66</td>
<td>0.70</td>
</tr>
<tr>
<td>Legislators, senior officers, and managers</td>
<td>1.83</td>
<td>0.41</td>
</tr>
<tr>
<td>Professionals</td>
<td>11.17</td>
<td>4.21</td>
</tr>
<tr>
<td>Technicians and associated professionals</td>
<td>4.05</td>
<td>1.66</td>
</tr>
<tr>
<td>Clerks</td>
<td>3.81</td>
<td>0.80</td>
</tr>
<tr>
<td>Service workers</td>
<td>11.70</td>
<td>3.94</td>
</tr>
<tr>
<td>Skilled agricultural and fisheries workers</td>
<td>45.95</td>
<td>80.04</td>
</tr>
<tr>
<td>Craft and related trade workers</td>
<td>6.40</td>
<td>3.47</td>
</tr>
<tr>
<td>Plant and machine operators and assemblers</td>
<td>2.30</td>
<td>0.89</td>
</tr>
<tr>
<td>Elementary occupations</td>
<td>8.10</td>
<td>3.86</td>
</tr>
<tr>
<td>Don't know</td>
<td>0.02</td>
<td>0.01</td>
</tr>
</tbody>
</table>

Table 5.9 presents the percent distribution of households’ main source of income for the constituencies in the area of interest. In all constituencies farming constituted the main source of household income.

The income from wages and salaries was larger in Mashare Constituency (12.9%) and Ndiyona (18%), but less significant in the Ncamangoro Constituency (6.4%) and Rundu Rural Constituency (6.9%). Large share of people depended on the old-age pensions, cash remittances, retirement fund, orphan or disability grants (Table 5.9), indicating dependency from income that is coming from social services or monies that are not generated by themselves, but provided by a relative or other person.

Table 5.9: Percent distribution of households’ main source of income by constituency (Source of data: NSA, 2014a&b).

<table>
<thead>
<tr>
<th></th>
<th>Ncamagoro</th>
<th>Ncuncuni</th>
<th>Ndiyona</th>
<th>Ndonga</th>
<th>Linena</th>
<th>Mashare</th>
<th>Rundu Rural</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farming</td>
<td>51.9</td>
<td>56.2</td>
<td>57.2</td>
<td>40.4</td>
<td>52.8</td>
<td>55.4</td>
<td></td>
</tr>
<tr>
<td>Business Activity (non farming)</td>
<td>15</td>
<td>8.2</td>
<td>5.8</td>
<td>5.7</td>
<td>6.6</td>
<td>6.7</td>
<td></td>
</tr>
<tr>
<td>Wages and Salaries</td>
<td>6.4</td>
<td>10.9</td>
<td>7.3</td>
<td>18</td>
<td>12.9</td>
<td>6.9</td>
<td></td>
</tr>
<tr>
<td>Old Age Pension</td>
<td>10</td>
<td>17.2</td>
<td>18.4</td>
<td>20.8</td>
<td>16.9</td>
<td>15.9</td>
<td></td>
</tr>
<tr>
<td>Cash Remittances</td>
<td>12.8</td>
<td>2.4</td>
<td>7.4</td>
<td>10</td>
<td>3.0</td>
<td>10.1</td>
<td></td>
</tr>
<tr>
<td>Retirement Fund</td>
<td>0.4</td>
<td>0.9</td>
<td>0.4</td>
<td>1.4</td>
<td>0.6</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>Orphan &amp; Grant</td>
<td>1.2</td>
<td>1.6</td>
<td>1</td>
<td>1.2</td>
<td>1.3</td>
<td>1.9</td>
<td></td>
</tr>
<tr>
<td>Disability Grant</td>
<td>1.8</td>
<td>1.7</td>
<td>1.1</td>
<td>1.8</td>
<td>1.7</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>0.3</td>
<td>1.1</td>
<td>1.4</td>
<td>0.6</td>
<td>4.4</td>
<td>1.2</td>
<td></td>
</tr>
</tbody>
</table>

There are major differences between urban and rural areas in Kavango regions. In urban areas, 46.3 % of the households reported wages and salaries as the main source of income, followed by business activities (non-farming) in 22.5 percent of all households. In rural areas, farming (57.6%) and old-age pensions (14.4%) were the main sources of income for households (NSA, 2014b).

The communities in the area of interest live under trying conditions. In 2011, Kavango region had recorded highest incidence of poverty of all regions in Namibia, 53% of all population, and representing decline of 5% points from the 2001 figure of 58% (World Bank and NSA, 2019).

Poverty is defined as the number of households who are unable to afford sufficient resources to satisfy their basic needs. The regional level poverty is defined as the percentage of the population within a region whose annual income consumption is below the poverty line.

The poverty line is defined as the minimum income level for determining the proportion of the population living in poverty. An individual is considered to be ρpoor when the annual per adult
equivalent consumption is below the upper bound (i̱poorôĩ N$4535.52) poverty line. When the annual per adult equivalent consumption is below the lower bound (ifsevere poorô N$3330.48) poverty line, an individual is considered to be fseverely poorô(NPS, 2015).

Fig. 5.16 shows that, with the exception of Rundu Urban and Rundu Rural West constituencies, in all the constituencies in Kavango region more than half of the population was poor. In 2011 all constituencies in Kavango region had poverty incidence above the national average 27%.

The highest poverty incidence was recorded in Kapako constituency (63%), followed by Kahenge, Mashare, Mpungu, all above 60% of population were classified as poor. The incidence of poverty in Mashare Constituency was 60.5% which was the third poorest constituency in Kavango Region (NPS, 2015). However, it had also the greatest poverty reduction (14.7%) between 2001 and 2011.

Table 5.10 shows ownership and access to selected items such as motor vehicles, bicycle, refrigerators, freezers, sewing/ knitting machines, radio, telephone (landline), TV, cell phone, donkey/ox cart, plough and tractor, among others.

It was observed that at national level, 93.3 percent of the households reported owning a cell phone, 30.9 percent reported having access to a motor vehicle and 86 percent did not have access to a telephone (landline).

Cell phone is common in both Kavango East and Kavango West Region where they are owned by 80.8% and 86% of the households respectively. Access to radio recorded only 39 and 49.6 percent in Kavango East and Kavango West respectively.

Both ownership of motor vehicle for the both Kavango Regions is the lowest. There are only 2% of households in Kavango West who own a motor vehicle, Kavango East has slightly higher ownership of motor vehicle i 5%, however still among the lowest in the country and is following after Kavango West.

Despite farming was named as a main source of income by majority of households in affected constituencies (Table 5.9), the ownership of a tractor is among the lowest in the country. Only 0.1% of Kavango East and 0% of Kavango West households owned a tractor. However, 19.2% of Kavango West households reported that they have access to a tractor. Only 2% of Kavango East households reported access to a tractor (Table 9). Ownership of a plough in households of Kavango East had 16.2% and Kavango West 43% (NSA, 2017c).
Table 5.10: Ownership of and access to assets (Source of data: NSA, 2017c).

<table>
<thead>
<tr>
<th>Selected Assets (%)</th>
<th>Namibia</th>
<th>Kavango East</th>
<th>Kavango West</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Owns</td>
<td>Has access</td>
<td>Owns</td>
</tr>
<tr>
<td>Motor vehicle</td>
<td>15.9</td>
<td>30.9</td>
<td>5.0</td>
</tr>
<tr>
<td>Bicycle</td>
<td>10.8</td>
<td>10.0</td>
<td>4.9</td>
</tr>
<tr>
<td>Refrigerator</td>
<td>37.8</td>
<td>10.3</td>
<td>23.9</td>
</tr>
<tr>
<td>Freezer</td>
<td>17.8</td>
<td>18.9</td>
<td>6.9</td>
</tr>
<tr>
<td>Sewing / knitting machine</td>
<td>7.8</td>
<td>11.0</td>
<td>3.1</td>
</tr>
<tr>
<td>Radio</td>
<td>45.6</td>
<td>30.9</td>
<td>39.0</td>
</tr>
<tr>
<td>Telephone</td>
<td>4.9</td>
<td>14.9</td>
<td>1.8</td>
</tr>
<tr>
<td>Television</td>
<td>42.5</td>
<td>27.1</td>
<td>28.8</td>
</tr>
<tr>
<td>Cell phone</td>
<td>93.3</td>
<td>8.5</td>
<td>80.8</td>
</tr>
<tr>
<td>Donkey cart / Ox cart</td>
<td>6.0</td>
<td>22.9</td>
<td>0.8</td>
</tr>
<tr>
<td>Pough</td>
<td>15.7</td>
<td>9.4</td>
<td>0.8</td>
</tr>
<tr>
<td>Tractor</td>
<td>0.6</td>
<td>9.0</td>
<td>16.2</td>
</tr>
</tbody>
</table>

According to the Inter-Census 2016 data the average household size (average number of persons in the household) of Namibia was 3.9 persons on average. The figure had decreased from an average of 4.4 persons recorded in 2011. At the regional level, Kavango West recorded the highest average number of persons in their household in Namibia and it was 5.2 persons in the household. This was a slight decrease from the average of 6.3 people in 2011. Kavango East had 4.1 person in the household in 2016 (NSA, 2017a).

In 2016 the majority of Kavango East households were headed by female (55.3%), but majority of Kavango West households were headed by male (57.6%). The trend for Kavango East had changed since the national census in 2011. If in 2016 the Kavango East households were headed by female, then back in 2011 the majority of Kavango East households were headed by male (Table 4.12).

Table 5.11: Percent distribution of household head by sex, year and area (NSA, 2017a).

<table>
<thead>
<tr>
<th>Area</th>
<th>Households 2011</th>
<th>Sex of household heads (%) 2011</th>
<th>Households 2016</th>
<th>Sex of household heads (%) 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Namibia</td>
<td>464839</td>
<td>56.2</td>
<td>43.8</td>
<td>589787</td>
</tr>
<tr>
<td>Kavango East</td>
<td>23050</td>
<td>55.4</td>
<td>44.6</td>
<td>35848</td>
</tr>
<tr>
<td>Kavango West</td>
<td>13691</td>
<td>60.0</td>
<td>40.0</td>
<td>17046</td>
</tr>
</tbody>
</table>

The 2011 Census data indicated that traditional dwellings were the most common type of housing unit, making up 72.9 percent of all households in Kavango regions. These were followed by detached houses (16.8%) and improvised housing units/shacks (4.3%). Traditional houses were most common in rural areas where they made up over 87 percent of housing units. In urban areas, detached houses and traditional housing units dominated (with a share of 37.3% and 40.1% respectively). In urban areas, improvised housing units/shacks made up 11 percent of housing units. By contrast, only 1 percent of rural households lived in shacks (NSA, 2014b).
The Inter-Census Survey in 2016 revealed that the most common housing in the area of interest was still a traditional dwelling. Around 77.1% of Kavango West households had traditional dwelling and 33.3% in Kavango East (Table 5.12).

Kavango East had recorded a large percent distribution of improvised housing units/shacks, it accounted for 46.7% of all households in Kavango East Region, and however this figure included urban area such as Rundu (NSA, 2017a).

Table 5.12: Percent distribution of households by type of housing unit and area (Inter-census survey 2016).

<table>
<thead>
<tr>
<th></th>
<th>Detached house/ Semi-detached</th>
<th>Apartment/Fl at</th>
<th>Single quarters</th>
<th>Traditional dwelling</th>
<th>Improvised housing unit (Shack)</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Namibia</td>
<td>30.8</td>
<td>6.1</td>
<td>2.4</td>
<td>32.6</td>
<td>26.6</td>
<td>1.4</td>
</tr>
<tr>
<td>Kavango East</td>
<td>16.5</td>
<td>0.7</td>
<td>2.4</td>
<td>33.3</td>
<td>46.7</td>
<td>0.4</td>
</tr>
<tr>
<td>Kavango West</td>
<td>7.3</td>
<td>1.0</td>
<td>0.6</td>
<td>77.1</td>
<td>13.7</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Households' main source of energy for cooking was fire wood. In Kavango East 80.5% of all households and 92.2% of all households in Kavango West used fire wood for cooking. Electricity from mains was used only by 13.4% of households in Kavango East and 6.8% in Kavango West (NSA, 2017a).

Households' main source of energy for lights were candles and batteries, less electricity. Around 27% of Kavango East households used batteries and 26.2% of households used candles, 30% of households used electricity. In Kavango West 54.8% households used batteries, 20.2% used candles and only 18.5% used electricity as an energy for lighting (NSA, 2017c).

5.4.2.3 Social Infrastructure and Services

The vital element for the assessment of the quality of life is to investigate quality of and reasonable access to social infrastructure and services. There were 170 schools in Kavango East with 63318 learners and 2006 teachers (MEAC, 2018). This made one teacher per 31.6 learners.

Kavango West had 176 schools with 42675 learners and 1523 teachers (MEAC, 2018), making one teacher per 28 learners.

There was a constant growth of population and demand for schools, particularly in Kavango East Region. In two years, from 2016 to 2018, the number of learners had grown by 4931 in Kavango East and 3840 in Kavango West Region (Fig. 5.17).

In average there was a continued trend of increase in the number of learners (by 3%), teachers (by 0.8%) and schools (by 2%) from 2017 to 2018 in Namibia. Similar trend was observed in Kavango East and Kavango West regions. In Kavango East Region the number of schools had grown from 162 schools in 2016 to 170 schools in 2018, creating 8 new schools. In Kavango West only 4 new schools were opened from 2016 to 2018, respectively 172 and 176 schools (MEAC, 2018).

The number of learners per one teacher (31.6 in Kavango East and 28 in Kavango West) was high and that was higher than national average 25.1 learners per one teacher (MEAC, 2018). This means the schools were somewhat overcrowded and would require more teachers and improved infrastructure.

In terms of health services and infrastructure, Kavango East and West regions were grappling with a shortage of nurses and doctors, inadequate infrastructure, and congestion due to a growing number of patients. Health centres that were supposed to provide relief for the heavily strained Rundu intermediate hospital were not only few but lacked the necessary infrastructure and resources to be fully functional (Sanzila, 2017).
There was 1 hospital in Kavango West Region, 17 Clinics, 6 Health Centres and 3 medical outreach posts. The Kavango East Region had 3 Hospitals (Andara, Nyangana and Rundu), 25 Clinics, 1 health centre and 3 medical outreach posts.

The Rundu hospital, one of Namibia’s four intermediate referral hospitals found in Kavango East Region, was under immense pressure following its transformation, attracting patients from other regions such as Zambezi, Kavango West and even beyond Namibia’s border in neighbouring Angola. Community members complained about the long distances they had to travel to access health services, for example, residents of Sauyemwa informal settlement that was about 6 kilometres west of Rundu.

Far distances, poverty and hunger were among the reasons resulting with HIV patients defaulting on their medication. Despite the challenges, the Health Directorate had stepped up efforts aimed at improving sexual reproductive health in the region. To mitigate the distance travelled by patients to access services, HIV and AIDS services had been decentralized (Sanzila, 2017).

There were three (3) police stations within the Kavango West Region, which were located at Kahenge, Mururani and Nkurenkuru and there were five (5) police stations within the Kavango East Region, located at Omega, Mukwe and Rundu (3 stations); and two police checkpoints at Muhembo and Rundu.

The Kavango West and East Regions have relatively good infrastructure, but most of the infrastructure is focused in central points or settlements' areas, with scattered and limited infrastructure found within the remote rural areas of the region.

The Kavango East Region is relatively well covered with a network of roads; unfortunately, most of these roads are gravel or sandy roads that make travel difficult.

Kavango East Region has one airport, at Rundu, that accommodates national flights. Several smaller airstrips cater for the tourism sector especially in the eastern part of the region.

Nevertheless, people living deep in the interior of the region are far from social infrastructure, thus access to education and medical treatment is difficult.

NamPower is the national power utility company in Namibia responsible for the generation and transmission of electricity. The regions are fairly well served with an electricity network, although this can be further developed especially within the further rural areas.
The communities living in the northern part of the Kavango West and East Regions along the road main tarred roads are relatively well connected to the national grid. The remainder of the rural communities situated away from the river and the main road are connected mostly with off-grid facilities that utilise either solar power systems or diesel power systems (MLR, 2015b).

The Okavango River is the main source of water for the people living along the river, and for their livestock, whereas villages away from river depend entirely on groundwater from boreholes supplied by the Ministry Agriculture, Water and Land Reform (MAWLR) and in some cases from seasonal pans. The urban areas - settlements and towns are provided with water by the NamWater.

The water quality of groundwater within the Kavango East Region is relatively good and suitable for human consumption with TDS (total dissolved solids) levels of between 501 – 1000 can be found within most parts of the Kavango East Region (MLR, 2015a).

In terms of access to water and sanitation, both Kavango East and West Regions are behind on the national average (Fig. 5.18).

![Figure 5.18: Access to water and sanitation in Namibia (UNCT, 2015).](image-url)
5.5 Subsurface Ground Components

5.5.1 Regional Geology and Petroleum System

The present-day Kalahari Basin owes its origin to the uplift of the Southern Africa continental margin during the break-up of African proto-type continent known as Gondwanaland (Summerfield, 1985); this tectonic event created what is now known as the The Great Escarpment by uplifting the Southern African continental margin followed by the down-warping of the continental interior creating the Kalahari Basin comprising the Kalahari Group sediments extending over much of Southern Africa inclusive of the proposed project area (De Swardt and Bennet, 1974 and Figs. 5.19 and 5.20).

According to Summerfield (1985), further local tectonic activities associated with reactivation of D3 deformation events of the Damara Orogen and the Eastern African Rift System caused further subsidence along graben systems of the central basin favouring thick sediment accumulations and creation of sub-basins.

The western sub-basins within which the study area is situated are locally dissected by numerous parallel faults which form graben; the most notable grabens to this study being the Omatako Graben. It therefore suffices to say that the Omatako River is largely structural-controlled.

It is based on the above-mentioned land mark structural and geomorphic units that the vertical and horizontal segregation, mineralogical content, texture, and grain size of the sediments of the study area will be theoretically framed and evidently contextualized. This will be particularly so in the subsequent sections and in the discussion and conclusions of this study. And within that theoretical frame and contextual evidence, the hydrogeological settings (groundwater) investigations of the study area will be interrogated and framed into a concept, with acknowledgements of data and information limitations.

Based on the limited geological information available in the area obtained from various water drilling projects, the geological of the survey area is likely to be comprise the Kalahari Group Sediments on the top sections followed by the Rooival (Drakensberg) basalt, Etjo Group, Karoo-aged sediments, and reef-prone Lower Paleozoic Units (Figs. 5.21 and 5.22).

Regional geologic investigations of the Permian Karoo Seaway, including main Karoo Basin, Botswana Kalahari Basin and Namibian basins Karasburg, Nama, Waterberg, Huab and Owambo support potential for adequate thickness of resource-prone sediments. Preliminary analyses indicate basin depths supportive of oil and gas thermal maturation levels.

Very little is known about the basement geology of the project area beyond the upper Karoo Formations as the boreholes drilled in the region rarely went beyond 200m depth. A review of aeromagnetic data of the Kavango Sedimentary Basin gave some idea of basement geology expected and perhaps depth to basement (Fig. 5.21). Separation filtering has been applied to aeromagnetic data to enhance and filter prominent features within the data set. The extent of the magnetic basement and dolerite sills and dyke swarms, underlain by Damara, which is known to outcrop in the area, is clearly visible from the resultant image. Figure 15 maps the anticipated basement geology which has been divided into categories namely Deep Karoo Basement, Karoo Flood Basalts, Karoo Basalt outcrop/sub-outcrop and Damara basement. The Karoo Flood Basalts underlies mostly the Kavango West and the north western parts of Kavango East. The eastern section of the Kavango East are found to be underlain by Damara Rocks, intruded by Karoo sills and dyke swarms. Further east in the vicinity of Mukwe and Popa Falls the area is underlain by Karoo Basalt in outcrop/sub-outcrop.

The extent of the Karoo flood Basalts are controlled by a northeast fault which is a separation between moderate and deeper basalts in the northwest, whereas the dolerite dykes and sills in the east are mostly controlled by vertical northwest striking features of faults and dykes. A northwest feature which is considered a vertical fault plane, displaces basalts deeper to the south, which is interpreted from drilling completed in the area to the south where bedrock was not intersected. Flood Basalts occurred along fault planes as depicted in Fig. 5.21, which are considered the conduits to lava flow.
Figure 5.19: Lateral extent of Kalahari Group sediments (Source: Haddon, 2005).
Figure 5.20: Surficial geology of PEL 73 and the proposed survey area.
Figure 5.2: Basement geology of the Kavango Sedimentary Basin (Julius, 2021).
5.5.2 Water Resources

5.5.2.1 Surface Water (Hydrology)

According to Oldeland et al. (2013), the Okavango River has its origin in the semi-humid highlands of Angola and drains the endorheic Okavango River basin through the arid and semi-arid eastern parts of Namibia into Botswana where it drains into a wetland, also known as the Okavango Delta (Fig. 5.22 and Table 5.13). The proposed 2D seismic survey area is not situated in the active catchment areas but in fossil channels of the Omatako Omuramba Ephemeral rivers which has not contributed to runoff from the Okavango for over 50 years (Oldeland et al., 2013).

The Okavango River basin upstream of the Delta covers an area of about 171,000 km² (Mohembo). About 95% of the streamflow entering the Delta is generated by two main tributaries, namely the Cubango River (108,000 km²) and the Cuito River (57,470 km²), both located in Angola (Oldeland et al., 2013).

The survey area covers three basins, the Kavango 1 and the Kavango 2 dissected by the graben controlled Omatako Basin (Fig. 5.23). In the Kavango 1 Basin streams essentially flow south-north into the Okavango River; deviating from the regional slope and probably emphasizing local structural control, whereas in the Omatako Basin the Omatako River flows north east into the Okavango River. Streams in the Kavango 2 Basin flow along the regional north east slope. It should be noted here that rivers initially follow slope and then adjust to local geologic structure as they incise their beds.

The present drainage within the survey area, although largely ephemeral apart from the Okavango River are exorheic, meaning that it allows flow into other external bodies of water for example rivers, swamps, and lakes. In this context they all drain into the greater Okavango River. This is true except for the Fumbe Stream which is endorheic (allows no flow into other external body of water).

Of interest to hydrogeology about drainage is stream network density (Dd), stream network frequency (Df), stream network texture, stream network topology and slope variations because these drainage aspects closely relate to dynamic nature of river sections or basin portions, dominant processes within basins/river sections, geology and geomorphology of basins/river sections and inform processes like run-off, infiltration, overland flow, sediment response and through flow.

In context of the above referenced value of stream/river aspects, in the far north west of the study area is Mpuku stream (Kavango 1 Basin) which displays high tributary network frequency (inter stream spacing along the trunk stream) of approximately a stream tributary every 12 km compared to other streams of relatively same distance coverage like the Fountain stream draining Ncaute, Ncuncuni to Rundu. Another high tributary network frequency is observed along the first 67 km of the Omatako River from the southern border of the study area. In that section of the Omatako Basin the Omatako River has a tributary every 5.4 km; thereafter the Omatako River has no tributary for about 85 km.

About stream network density (sum of stream length per unit area of section of basin), km/km² the dissected portion of the Omatako Basin& Dd is estimated at 0.033 whereas that of the Mpuku stream is approximately 0.072, meaning that the Mpuku Stream drainage area& runoff potential is relatively two-fold more than that of the dissected portion of the Omatako River. However, it should be qualified here that stream density (Dd) values of less 5 (0.033 for Omatako River, and 0.072 for the Mpuku stream) imply coarse stream texture which is characteristic of dry regions with none perennial flow or flow only during rainy seasons.

These observations allow inference into the dynamic and active drainage portions of the study area. Portions outside the ones marked dynamic are either quiet or relatively less dynamic, and play roles of sediment and run-off accommodation, through flow, and infiltration sites. The two areas marked dynamic portions in Fig. 5.23 are the relatively dynamic drainage portions of the study area, and it is expected that these are sites of erosion, run-off, and overland flow.
Figure 5.22: Okavango River Basin including all main tributaries and the Okavango Delta with its entrance at Mohembo gauging station and outlet at Maun (Source: Oldeland et al. 2013).
Drainage analysis efficiently links to surface-water Groundwater interaction, therefore the observations presented above offer an opportunity to infer the surface-water Groundwater interaction dynamics of the study area in view of preferential sites, losing or gaining, pathways, infiltration potential, and flow fields.

In the above given context and about surface-water groundwater interaction, it is important to note that the rivers/streams in the study area are of coarse stream texture and only flow in exceptionally wet seasons and for short periods, this keeps their stream beds above the groundwater table for most of the time. Therefore, when they flow after good rains, they tend to lose the water to the sub-surface flow, with high evapotranspiration. This becomes even more-so considering that they are low gradient streams (gradient of less than 2%).

The Omatako River and are potentially areas of surface water ponding, infiltration, and groundwater through flow. Productive boreholes will then be preferable located in the last quarter of the active zone to the second half of the inactive zone, this inference is based on the observed relative high mass transport capacity and the observation that this section of the Omatako River cuts from the western banks and buries on the eastern banks of the channel. Therefore, productive boreholes in this section should be bias towards the eastern side of the river channel.

The proposed 2D seismic survey operations will be undertaken along existing roads and tracks with little to no interference to surface water system of the area.

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Other names</strong></td>
<td><strong>Countries</strong></td>
<td><strong>Region</strong></td>
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<tr>
<td>Kawango</td>
<td>Angola, Namibia, Botswana</td>
<td>Southern Africa</td>
</tr>
<tr>
<td><strong>Tributaries west (Cubango Catchment)</strong></td>
<td><strong>Tributaries east (Cuito Catchment)</strong></td>
<td><strong>Cities</strong></td>
</tr>
<tr>
<td>Cubango, Cutato, Chuchi, Cacuchi, Ceile, Cuebe, Cueio, Cuatir</td>
<td>Cuito, Cuanavale, Lussinga, Longa, Cuiriri</td>
<td>Menongue (Angola), Rundu (Namibia), Maun (Botswana)</td>
</tr>
<tr>
<td><strong>Source</strong></td>
<td><strong>Source location</strong></td>
<td><strong>Source elevation</strong></td>
</tr>
<tr>
<td>Bié Plateau (Central Plateau of Angola)</td>
<td>Close to Tchicala Tcholohanga (other names: Vila Nova, Chicala Choloanga) near the village/settlement of Lumbula</td>
<td>1,850 m approx.</td>
</tr>
<tr>
<td><strong>Source coordinates</strong></td>
<td><strong>Mouth</strong></td>
<td><strong>Mouth elevation</strong></td>
</tr>
<tr>
<td>12°42′40.76″ S, 16°03′50.48″ E</td>
<td>Between Seronga (east) and Ikoga (west) into the Okavango Delta (Botswana)</td>
<td>Outlet of the Panhandle between Seronga and Ikoga: 980 m; Maun: 940 m (Delta outlet)</td>
</tr>
<tr>
<td><strong>Mouth coordinates</strong></td>
<td><strong>Length</strong></td>
<td><strong>Basin</strong></td>
</tr>
<tr>
<td>18°50′40.76″ S, 16°03′50.48″ E</td>
<td>Cubango: 1,260 km approx., Cuito: 320 km approx., Okavango (including the Delta until Maun): 1,860 km approx.</td>
<td>185.000 km² approx. (until the entrance into the Panhandle at Mohembo)</td>
</tr>
<tr>
<td><strong>Discharge average</strong></td>
<td>304 m³/s approx (Station Mukwe, 10/1949 - 09/1988)*</td>
<td></td>
</tr>
</tbody>
</table>
5.5.2.2 Hydrogeology

5.5.2.2.1 Overview

Julius, (2021) has compiled the hydrogeology component of this EIA Report as part of larger ongoing study and water monitoring activities in PEL 73. The occurrence of groundwater within the Kavango Basin can be broadly divided into: Primary of saturated Kalahari Sediments of the Kalahari Group and secondary aquifers of fractured/faulted and weathered bedrock geology. The groundwater potential for the Kavango Region can be described as moderate to low, despite the chance of finding water, is often. Water Quality for most places is considered good quality water, especially in the western territories with greater Kalahari thickness. However, there are areas where groundwater is of bad/poor quality, and has been the cause of suffering to many communities having no access to drinking water. Poor quality groundwater is mostly located to the east where the Kalahari sediments are thin and has limited saturated thickness. These boreholes penetrate secondary aquifers within bedrock features with poorer water quality. Poor quality water is associated with stagnant waters.

Attempts have been made to correlate Kalahari stratigraphy with groundwater regimes. Upper, lower, and middle Kalahari aquifers have been suggested to correlate with Tsumkwe, Eiseb and Omatako Formations (Hegenberger 1982). However very little is known about their geohydrology in terms of lateral extent, its yield and expected water quality. To fully understand the aquifers found within the Kavango Region, greater research is still required to investigate the prevalent groundwater regimes of the Kavango Basin. Research will separate favourable areas of good yield and quality from areas where groundwater are of an inferior quality. Dumushe (in Otjozondjupa) is one area where shallow good quality water overlies water of a poorer quality. The community uses water from shallow wells for drinking and water from deeper penetrating boreholes for livestock.

Boreholes drilled next to and along the Okavango River, intersect paleo-channels of the Okavango river, with often high yielding boreholes, mostly used for Bulk Water Supply Schemes. It has been found with deeper drilling along the river that a confined (artesian) saline aquifer underlies the paleo-channel (alluvium) aquifers on top.

5.5.2.2 Depth to Groundwater

Approximately 35% of boreholes extracted from the Groundwater Information System (GROWAS II) database held by the Ministry of Agriculture, Water and Land Reform (MAWLR) did not contain any rest water level data. Surface heights were allocated to borehole data for 1047 boreholes. Boreholes with inadequate data were omitted from the database for creating a piezometric surface. A total of 682 boreholes had rest water levels which was used to generate a surface and contour plot of the piezometric surface.

A contour map of rest water level was produced, which is an indication of the depth to groundwater (Fig. 5.23). Noticeable, is that there is a separation in the depth to groundwater which coincides with a northwest fault line, a prominent geological feature. It is understood that this feature represents weak zone/fault which acted as conduit for magmatic basaltic lava flows. This fault line separates groundwater to the south, with depths of between 80-120m, from shallower groundwater to the east, with water levels less than 60m. Fig. 5.23 further reveals a shallow water zone occurring along a north-south line that passes through Rundu and stretches for approximately 120km. Water along this feature is not deeper than 25m. This zone seems to follow the valleys of ephemeral rivers/Omirambas in that vicinity and terminates against the northwest boundary fault which causes a steep gradient of water level rise further to the south.

Apart from zones of shallow water along the river, the Kavango West Region has groundwater located deeper than 80m. Groundwater for the most part of the Kavango East Region is shallow and is not deeper than 40m. Close to the river water levels are less than 20m. However there seems to be a steep gradient where water levels drop from 40m below ground level to levels of 15m over a short distance next and close to the river. The depth to groundwater in actual effect, provides an overview of the pump inlet depth to abstract water from. The deeper the groundwater, the greater the depth in abstracting water from, for a particular area.
5.5.2.2 Groundwater Flow

It is widely accepted that groundwater flow mimics the topography, which means water will flow from the south, north towards the Okavango River, and to the east towards the Okavango Delta in Botswana. This perhaps is true, on a broad scale but local change in flow can be expected. Fig. 5.24, is a piezometric surface created to determine the flow of groundwater in the region. Three groundwater highs are depicted in Fig. 5.24, from where groundwater flows away to lower/depressions.

One of the significant depressed zones lies south of the northwest fault zone which is the boundary between deep and shallow waters and act as a graben where water is draining into. North of the Omatako Omuramba, groundwater flows north, whereas south of the Omatako Omuramba water drains south.

In the north in the vicinity of Nkurenkuru, there is a northwest high from where groundwater drains south towards the ephemeral rivers, and then towards the Okavango River. A general NW-SE area of elevated groundwater, running parallel to the river, has groundwater draining first inland towards ephemeral rivers, then north-eastwards towards the main river flow.

Groundwater in the south east in the vicinity of the northern dyke swarms, water drains south-south-east (SSE) in the direction of the Okavango Delta. The lowest groundwater is in the east in the vicinity of Andara and Popa Falls, where water follows in the direction of the river. At the western edge of the of the license area, groundwater is connected to the Ovambo Basin, flowing in a south-westerly direction. In the Ngoma-Baramasoni area groundwater seems to accumulate in this depression.

From the piezometric surface plot it can be determined that groundwater flow is quite complex and is not as simple as just water flowing following the general topography, which is south to north and west to east. The significance is that recharge of the Kalahari Aquifers is from different areas, which is mainly in the south but also from areas in the central part of the license area and all linked to rainfall as key source of recharge for Kalahari Aquifers. Groundwater flow is to some extent the manifestation the faulting found in the area. The overall groundwater gradient for the PEL area is generally low-gentle.

5.5.2.4 Borehole Yields

The lowest yield of 0.08m$^3$/h was recorded for the dataset with the highest yield of 98m$^3$/h, with an average of 10m$^3$/h and a median of 7.8 m$^3$/h (Fig. 5.25). The statistics reveal that the majority of boreholes have yields between 2-4 m$^3$/h, followed by boreholes with yields between 8-10m$^3$/h, with a median of approximately 8m3/h. This suggests that boreholes on average have moderate yields of 8m$^3$/h. These yields are significant in relation to other parts of Namibia, where rural water supply borehole yields are perhaps less than 4m$^3$/h in general.

Exceptional yields of 50-98 m$^3$/h have been recorded for certain boreholes, which is mostly in close proximity to the Okavango River. Higher yielding boreholes further away from the Okavango river is an exception to the rule. Overall boreholes tapping the Kalahari Aquifer have above average yields compared to other parts in Namibia, which suggest that groundwater potential is good. The concentration of boreholes are denser in the vicinities closer to the Okavango River where most of the population also live. Areas of lower density are found furthest east (Khaudom) and further west, north of the commercial farms, where access to these areas are cumbersome. To some extent borehole yield is influenced by the design of a borehole, where a poor design can result in a loss of yield capacity due to poor well performance. This makes the correlation of yield with other geohydrological parameters or lithologies and stratigraphy cumbersome.

There is a remarkable difference in yield from borehole east and west of Mururani, the veterinary checkpoint. Higher yielding boreholes to the west are influenced by basement faults striking northeast, which originates in the vicinity of Tsumeb, where Otavi Dolomite are cropping out. In the east, boreholes are deeper and intersect water at greater depths, with lower saturated thickness and yields. This is classic example of where bedrock features contributes to greater yield capacity despite both sets of boreholes intersecting Kalahari sediments.
Figure 5.23: Depth to groundwater map for PEL 73 (Julius, 2021).
Figure 5.24: Piezometric surface map for PEL 73 (Julius, 2021).
Figure 5.25: Boreholes yields for PEL 73 (Julius, 2021).
5.5.2.2.5 Water Quality

Water Quality is essential to ensure water does not pose a potential risk to the health of people, the environment, animals and aquatic ecosystems. Water quality analysis determines whether water has no adverse effect on the fitness of water for a specific use. Water quality is being described by its physical, chemical, biological and aesthetic properties to determine its fitness for a variety of uses. Water quality properties are determined by constituents/determinants dissolved or suspended in water. The Water Quality Guidelines is a set of information provided by constituents, with a water quality range for each constituent and the norms used to assess its effects, and how effects might be mitigated and possible remedies/treatment options.

According to the Namibian Guidelines for the evaluation of drinking water for human consumption with regard to chemical, physical and bacteriological quality water is classified as A (Excellent), B (Good), C (Poor (low risk)) and D (Unsuitable for human consumption).

Water Quality data has been deduced from an extract from GROWAS II Database. The latest water quality analyses were selected as a representation of water quality of a particular water point, since more than one analysis were exported from the GROWAS database. Total Dissolved Solids (TDS) are a good indicator of the overall water quality and will be the determinant used to evaluate the water quality at a regional level. Based on the TDS, will the quality of water be classed as class A, B, C or D. Class A and B are accepted ranges of water quality with class C and D, not acceptable for human consumption. A total of 717 records have been extracted from the reduced GROWAS database.

A histogram plot of TDS was constructed from water chemistry data from GROWAS. 90% of the data had a TDS between 500-1000mg/l (ppm), which is considered water of good quality and of Class B at least. The average TDS for this dataset was 745ppm which is water of Class A, according to the Namibian Guidelines of Water Quality (Table 4.3).

About 75% of the data falls within the category of good quality water. The highest TDS recorded for boreholes of the Kavango Region is 24,799ppm. Water Quality exceeding a TDS of 2,000ppm is considered Class C and is not fit for human consumption. About 86 (12%) samples exceeded this value.

Despite the occurrence of poor quality groundwater, groundwater of good quality does exist, in the vicinity close by, normally not further than 5km. It is inferred that poor quality water occurs in the same vicinity of high yielding boreholes, which is associated with bedrock aquifers and stagnant water (Fig. 5.27). Poorer water quality might also be associated with the saline aquifer water below a fresh water aquifer.

Care should be exercised in areas of shallow bedrock, to ensure drilling does not intersect these layer of poorer water quality. It is in the opinion of the author (Julius, 2021), that poorer water quality is associated with stagnant water in areas underlain by basalt bedrock, where the Kalahari aquifer is fairly thin.

However, no correlation could be established between poorer water quality and any lithology or stratigraphy. Boreholes with poorer water quality is high in sodium salts (NaCl₂ and Na₂SO₄), which is indicative of stagnant water with high resident times.
Figure 5.26: Water Quality (TDS) map of PEL 73 (Julius, 2021).
5.5.2.2.6 Recharge

The quantification of recharge is complicated and is not supported by the monitoring of wells, which is lacking for the majority of the area. Recharge is calculated as a function/fraction of rainfall. Attempts have been made to estimate the recharge of the Kavango Sedimentary Basin, with results suggesting values of as little as 1mm/annum of mean annual precipitation or 1 litre per square meter (l/m²). In the absence of good scientific data, recharge as a rule of thumb is taken as 1% of precipitation for Namibia, which estimates recharge to be 120l/m², with an annual average rainfall of 500mm.

Various attempts on determining recharge indicates a significant variation in results, which requires proper research to make sense of actual recharge. This will require a proper monitoring network, equipped with weather stations at water points for this purpose. However, in the absence of proper data a fraction of annual precipitation is a crude method of estimating annual recharge.

Areas of recharge for boreholes in the west are from northeast conduits/fault zones originating in the vicinity of Tsumeb, which results in shallower groundwater and greater borehole yields. Recharge for boreholes on the eastern side of Mururani, and parts inland from the Okavango River, gets recharged from local rainfall.

It is believed that the deeper aquifer below the flow of the Okavango River is fed by recharge from the Kalahari aquifers, elsewhere, where aquifers are shallow, the Okavango is responsible for its recharge. Water quality is known to deteriorate over time. Recharge (Rainfall) plays a vital role in maintaining water quality with each episode of recharge. Since no monitoring is done including Kalahari aquifers, the changes in water quality over time is not quantified.

5.5.2.2.7 Aquifer Thickness

The data within in GROWAS does not contain information on the lithologies intersected for most boreholes in the area. Only a few boreholes have data regarding the lithologies intersected. This makes the determination of aquifer thickness difficult. However, the saturated thickness can be estimated and defined as the thickness between the first water strike and the final depth of the borehole which gives you an idea of arbitrary aquifer thickness.

The data reduction exercise revealed a few shortcomings, within the database. Some boreholes had water strike data, but not a final depth. Some boreholes had no water strike and final depth data, but had a 2nd water strikes recorded. Erroneous data was removed from the dataset for the calculation of saturated thickness. From the analysis the following main points have been recognised (Fig. 5.27):

- The average depth of boreholes is 94m, with a minimum of 15m and a maximum of 317m.
- The average water strike is 51m, with a minimum of 4m and a maximum 150m.
- The average saturated thickness for the region is 43.4m, with a minimum of 3m and a maximum of 225m.

Kalahari thickness could not be determined from existing borehole data from GROWAS. Very few boreholes had depth to bedrock or Kalahari thickness recorded. The Kalahari isopachs plotted infers that the Kalahari sediments increase in depth from east to west to southwest and increase in thickness of up to 350m. A depth of over 300m seems like an over estimation, as this depth is possibly derived from boreholes intersecting the Etosha-Cuvelai Basin.

Maps of depth to water strike and saturation thickness with borehole depth has been compiled, which is another indication of depth to groundwater and the yield capacity of a borehole. Saturated thickness gives you an idea of the groundwater potential of the area. The greater the column of saturation the greater the yield capacity anticipated.
There is a marked difference in water encountered by boreholes, below or south of the northwest fault, where water was struck water at depths greater than a 100m, whereas in the west, west of Mururani, along the southern border, water strikes are less than 50m becoming shallower progressing southwest towards Tsumeb (Fig. 5.28).

It is believed that the two northeast faults south and west of Tsumeb are conduits giving rise to this elevated water table. Elsewhere south of the Kavango river, water strikes are found to be between 50m and a 100m. Water strikes close to the river are less than 25m. Near the first two stratigraphic wells water is expected to be shallow and will be intersected/struck within the first 50m of drilling.

The saturated aquifers thickness in relation to borehole depth are shown in Fig. 5.29. Very few boreholes have saturated thicknesses greater than a 100m. The majority of boreholes have a saturated thickness between 40-60m. Deeper boreholes south of the prominent northwest fault has saturated thickness of less than 25m, despite increased drilling depths of greater than 140m. This suggests boreholes will have lower yields in comparison to borehole with greater saturated thickness. This rationale, however is only applicable to boreholes tapping Kalahari sediments.

Borehole saturation thickens in the vicinity of exploration wells, implies boreholes will have a saturation thickness between 50-100, with depths rarely exceeding a 150m.

![Saturated Thickness Histogram](image)

Figure 5.27: Saturated Thickness, Histogram (Julius, 2021).
Figure 5.28: Water strike depth, with borehole depth around PEL 73 (Julius, 2021).
Figure 5.29: Saturation thickness with borehole depth around PEL 73 (Julius, 2021).
5.5.2.2.8 Groundwater Use and Abstraction

The major consumers of groundwater, are communal farmers, who are widely spread across the Kavango West and East Regions of PEL 73 and use water mainly for livestock and domestic use. No formal abstraction records are kept by farmers, which makes the calculation of water abstraction by farmers impossible.

Water being consumed by community water points is also not being metered and is therefore not known. The impact of water abstraction by communities is difficult to determine. Various attempts have been made to determine the water demand per water point, but the figures produced are unreliable, especially the livestock numbers per household per water point. Relying on census population data is also cumbersome since the number of people served by the number of water points in an enumerator is also elusive.

However given the data available, an attempt was made through the use of spatial analysis and assumptions on the number of livestock per hectare, to determine an average water demand figure per enumerator per borehole.

The water demand per enumerator has been calculated based on the number of livestock it can support per hectare (10LSU) and the population size per enumerator. Approximately 80 litres per day (L/day) have been allowed for water consumption for both livestock and people. A spatial join was done on census data which assigns the number of boreholes to its enumerator which it contains. Results of the analysis were as follows:

- The least water required is 0.005m$^3$/h or 0.14m$^3$/day and the highest of 5.9 m$^3$/h or a 141m$^3$/day, with an average of 0.9 m$^3$/h or 22 m$^3$/day.

- Borehole Yield on average can supply approximately between 8-10 m$^3$/h or 192-240 m$^3$/day.

The results of the analysis determines that the average borehole yield, satisfies the required water demand per water point. The required water demand for petroleum exploration especially well drilling operations has been determined as approximately 7m$^3$/h, which is close to the average borehole yield for the region. Operational or safe yield, is normally taken as 70-80% of sustainable yield. This indicates that a borehole must yield at least 9m$^3$/h to fulfil the water requirements of petroleum drilling operation but far more less proposed 2D seismic survey operations that will only require water for human use.

Only farms under irrigation of more than 1ha, require a permit, or if water is for other use, other than domestic/farming. Other users of groundwater are schools, clinics and police stations and other amenities. Schools and clinics have exclusive water points, however these installations get shared with the communities. These water points are assigned to Rural Water Supply in the Regional Council.

The Namibian Water Corporation (NamWater) is the official bulk water supplier of settlements and villages. NamWater has a few schemes in the Region, which is mostly located along the river. All NamWater groundwater schemes draw water from aquifers close to the Okavango River and do not draw water from the river. Water from boreholes has the advantage that it does not require purification or treatment.

5.6 Archaeology

5.6.1 Overview of Archaeological Resources in PEL 73

The archaeological inputs and assessment for this project has been provided by Nankela, (2021). Previous systematic archaeological investigations of the Kavango East and West Regions revealed human occupations that predate the pre-colonial farming settlements. In addition to archaeological heritage, modern heritage of Kavango East and West Regions is characterised by remnants of numerous historic, sacred cultural sites as well as present-day community graves and cemeteries mainly along the Omatako River basin not affected by the proposed 2D seismic survey operations.
5.6.2 Archaeological Baseline Findings

The archaeological heritage impact assessment study has only identified a group of archaeological heritage sites within the footprint of the proposed project. These are located along the Omatako River basin between Ncute and Taratara villages (Table 5.14 and Fig. 5.30). Additionally, a group of other sites whose quantity has not been established are also found southwest of Omatako River basin.

These sites will not be impacted by the proposed 2D seismic survey operations neither are they vulnerable nor sensitive. However, it cannot be ruled out that other significant archaeological evidence of pre-colonial occupation will likely be found along the tributaries of the Omatako River basin mainly due to the presence of fresh water in the immediate area.

If they do occur, the nature of anticipated archaeological materials along the Omatako river course will likely be of diagnostic nature from Late Stone Age period due to the spread of the industry in this area. However, such surface artefacts will have no archaeological values because they will likely be been already disturbed by extensive agricultural activities all along the Omatako Ephemeral River and associated tributaries (Plate 5.21).

Table 5.14: GPS coordinates of the identified archaeological sites reflected in Fig. 5.30.

<table>
<thead>
<tr>
<th>Site No.</th>
<th>GPS location</th>
<th>Region</th>
<th>Constituency</th>
</tr>
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<tbody>
<tr>
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<td>Mcumu/Chimpanda</td>
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<td>2</td>
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<td>Baramasono</td>
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<td>4</td>
<td>18°11'1.21&quot;S / 20°10'15.72&quot;E</td>
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<td>Baramasono</td>
</tr>
<tr>
<td>5</td>
<td>18°10'59.89&quot;S / 20°11'18.68&quot;E</td>
<td>Kavango East</td>
<td>Taratara</td>
</tr>
</tbody>
</table>
Figure 5.30: A group of archaeological sites (red dots, quantities not established) in relation to the proposed 2D seismic survey lines (red lines) to be conducted along existing roads and tracks. The blue lines indicate the Omatako Ephemeral River channels (Nankela, 2021).
Plate 5.21: Extensive human induced disturbances including agricultural activities all along the Omatako Ephemeral River and its Ephemeral tributaries that could have resulted in the disturbances of any archaeological resources in the area.
5.7 Stakeholder and Public Consultation

5.7.1 Overview

According to the Environmental Impact Assessment (EIA) Regulations No. 30 of 2012 and the Environmental Management Act, (EMA), 2007, (Act No. 7 of 2007), a person conducting a public consultation process must give notice to all potential Interested and Affected Parties (I&APs) of the application for ECC which is subjected to public consultation and participation process. The EIA Regulations clearly state that potential interested and affected parties must be provided with a reasonable opportunity to comment on the application under section 21(6) of the EIA Regulations.

Consultation of the Interested and Affected Parties (I & APs) is part of the EIA process for the proposed 2D seismic survey operations in line with the environmental regulatory requirements. Due to the specialised nature of the proposed project activities and situated in remote communal areas, the project team will focus heavily on working with the regional, local and traditional leaders who be responsible for informing their local communities about the proposed activities.

Continuous consultation and updating of the political (Governors and local Councillors) and traditional leaders of the Kavango West and East Regions about the proposed activities will continue to be undertaken in order to make sure that the local community are kept up to date on the ongoing activities and do not feel afraid if they happen to come across the exploration team in area.

5.7.2 Public Notices Published

Prior to the implementation of the public and stakeholder consultation processes as part of the formal project registration with the Government, a Draft Scoping Report with Terms of Reference for the EIA and EMP phases was prepared and submitted to the Environmental Commissioner in the Ministry of Environment, Forestry and Tourism through the Petroleum Commissioner in the Ministry of Mines and Energy.

Public and stakeholder consultations process covering all the Interested and affected Parties (I&APs) was conducted during the months of January and February 2021. A total six (6) public notices were published in the local newspapers as follows (Figs. 5.31 i 5.36):

1. New Era Newspaper dated Thursday, 7th January 2021 (Fig. 5.31).
2. The Namibian Newspaper dated Wednesday, 13th January 2021 (Fig. 5.32).
3. the Confidente Newspaper dated 14th i 20th January 2021(Fig. 5.33).
4. The Market Watch insert in the Republikein, Allgemeine Zeitung and Namibian Sun newspapers dated Friday, 15th January 2021(Fig. 5.34).
5. The Market Watch insert in the Republikein, Allgemeine Zeitung and Namibian Sun newspapers dated Monday, 18th January 2021 (Fig. 5.35), and.
6. Public notice for the extension of the dealing for submitting comments, inputs, or objections from Friday 29th February 2021 to Friday, 12th February 2021 that was published in the New Era Newspaper dated Monday, 8th February 2021 (Fig. 5.36).
Figure 5.31: Copy of the public notice that was published in the New Era Newspaper dated Thursday, 7th January 2021.
Harnessing Social Media Marketing

TYENIMOLO LEONARD

Social media marketing is one of the most effective ways to reach a large audience with a very small budget. The ability of people according to their age, hobbies, sport interests, political ideology, place of work, and where they live. There has never been such a revolution in the use of the internet and social media before. It is not just for businesses to use social media, but it seems we are far from understanding how and when to use it. Most businesses use social media as a platform with limited features, which is not useful. Unlike advertising or a newspaper, one should think of social media as a beautiful flower that is connected to sunlight, water, and nutrients in the soil. The more you water it, the more it grows, and the more beautiful it looks. But you have to know when to water it, how much water to give it, and where to plant it. Many businesses are doing things wrong. They design attractive artworks, which good, but do you think people spend time on social media to look at artworks? Social media users tend to skip and completely ignore advertisements. The best way to position your business on social media is through organic content. Social media users are looking for socializing with the posting content. People like to buy, but dislike being sold products. Everyone has been to a furniture store or a clothing store. Has the salesperson ever said, “Do you want me to breathe?” And some sellers try to force customers to buy their products. Very annoying, isn’t it? Straightforward advertising and sponsored content on social media platform have the same effect too great. Content is king, so we have to create content that delivers value to the audience, which is through fun activities, appealing images of models and social media influencers, or educational content, storytelling, and tips. There are two fundamental reasons why people spend time on social media. Some want to look at other people’s lives and compare themselves to other beautiful and attractive people. Some need time on social media to look at beautiful women and send them direct messages in the hope of getting them on dates, or recruiting them for promotions. Men are drawn by visuals. Other factors also contribute to social media usage, such as boredom and loneliness, especially when people are not on social media. Don’t think people are using social media that only seems to impress other graphic designers. Tell your story. People like to be inspired. They trust authentic stories and brands that share stories through videos and pictures of real people. Stay away as far as possible from using images that are too generic or have a very neutral color. The text must be clear. Don’t pretend. Don’t pretend that your product is amazing. People want to know your product. Your content must be written in a way that is easy to read and to understand. It is better to have a simple format.

* Tyenimo Leonard is the chief executive officer and founder of Comm Some Advertising.

Figure 5.32: Copy of the public notice that was published in the Namibian Newspaper dated Wednesday, 13th January 2021.
Figure 5.33: Copy of the public notice that was published in the Confidente Newspaper dated 14th to 20th January 2021.
Figure 5.34: Copy of the public notice that was published in the Market Watch insert in the Republikein, Allgemeine Zeitung and Namibian Sun newspapers dated Friday, 15th January 2021.
Figure 5.35: Copy of the public notice that was published in the Market Watch insert in the Republikein, Algemeine Zeitung and Namibian Sun newspapers dated Monday, 18th January 2021.
Copy of the public notice for the extension of the dealing for submitting comments, inputs, or objections from Friday 29th February 2021 to Friday, 12th February 2021 that was published in the New Era Newspaper dated Monday, 8th February 2021.
5.7.3 Stakeholders, Public and Community Meetings Undertaken

The following public meetings were held in Kavango West, Kavango East and Khomas Regions during the months of January and February 2021 as part of the stakeholder and public consultation process for the proposed 2D seismic survey operations in PEL 73 (Tables 5.15 - 5.28):

1. Kavango East and West Regions Ministry of Environment, Forestry and Tourism stakeholders consultation and field-based visits/verifications of the proposed 2D seismic survey area and drilling locations undertaken on the 18th and 19th January 2021 (Table 5.15 and Plates 5.22 and 5.23).

2. Nkurenkuru Kavango West Region formal public meeting (morning and afternoon sessions) held at Nkurenkuru Community Hall on the 20th January 2021 (Table 5.16).

3. Rundu Kavango East Region formal public meeting (morning and afternoon sessions) held at AMTA Rundu on the 22nd January 2021 (Table 5.17).

4. Sivaradi 1 and 2, Kavango West Region formal community meeting held under the community meeting tree on the 23rd January 2021 (Table 5.18).

5. Gcaru, Kavango West Region formal community meeting held under the community meeting tree on the 23rd January 2021 (Table 5.19).

6. Ncuncuni, Kavango West Region formal community meeting held under the community meeting tree on the 25th January 2021 (Table 5.20).

7. Ncaute, Kavango East/West Regions formal community meeting held under the community meeting tree on the 26th January 2021 (Table 5.21).

8. Makandina, Kavango East Region formal community meeting held under the community meeting tree on the 27th January 2021 (Table 5.22).

9. Windhoek, Khomas Region formal public meeting held Hotel Thule, Windhoek on the 2nd February 2021 and organised by ReconAfrica and Namibia Chamber of Environment (NCE) (Table 5.23).

10. Mutwegombahe, Kavango East Region formal community meeting held under the community meeting tree on the 8th February 2021 (Table 5.24).

11. Mbambi, Kavango East Region formal community meeting held under the community meeting tree on the 8th February 2021 (Table 5.25).

12. Cuma, Kavango East Region formal community meeting held under the community meeting tree on the 8th February 2021 (Table 5.26).

13. Omega 1 Community, covering Omega 1, Chetta, Mangarangandja, Mutjiku, Mushashani and Mshasha Villages in Bwabwata National Park, Western Zambezi Region (18th March 2021, morning Session) 10:00 -12:00 (Table 5.27), and.

14. Masambo Community, covering Masambo, Poca, Omega 3, Chetto, Muteik, Pipo and Ionxei villages in Bwabwata National Park, Western Zambezi Region, 18th March 2021, (Late Afternoon Sessions) 16:30 -19:00 (Table 5.28).

The following is the summary of the delivery methods used at the various meeting:

1. MEFT stakeholder consultation process combined formal meeting with PowerPoint presentation and posters held in Rundu with field-based visits and verifications of the actual site conditions (Table 5.16). Field-based presentation and discussions were held in the field (Plates 5.22 and 5.23).
2. Public and stakeholders meetings in Nkurenkuru, Rundu and Windhoek combined PowerPoint presentations with posters sessions, and.

3. Community meetings in Kavango West and East regions were delivered using posters, printed handouts and simplified physical illustrations and local landscape examples to explain key aspects of the proposed project activities (Plates 5.24 and 5.25). For instance, a camping mattress was used to create folding and illustrate the formation of a sedimentary basin. The sediment infilling in the Omatako Ephemeral River or local ephemeral river was also used to explain how sedimentary basins are formed over millions of years. The local elders who attended the meetings also attested to the fact that Omatako Ephemeral River and the local tributaries used to flow many years ago but now the channels have been filled-up by sediments and are no longer flowing rivers. In demonstrating the formation of a sedimentary basin the folds on the mattress were then filled up with sand and compacted to illustrate the formation of a petroleum system (Plate 5.24). Various plumbing pipes were used in demonstrating how the drilling operations is undertaken in studying the sedimentary basin with real drill core provided to the communities to show the samples being collected from the ongoing stratigraphic well drilling operations.

4. The proposed 2D Seismic survey operations were explained using detailed and enlarged images of the energy sources and receivers. Dumbbells were set in a line on the ground to illustrate how the wireless receivers will be planted along the existing roads and tracks to look for possible geological structures called reservoirs that might hold oil or gas within the sedimentary basin. A mental plate with a weight was used to demonstrate how the source will generate the sound waves that will be used to map the subsurface below each of the proposed 2D seismic lines (Plate 5.24).

5. Translation from English to Rukwangali was provided by Mr. Izaac Veijo, Mr. Alois Gende, Mr. Hausiku Hubert Sindimba coupled with great interactions and contributions from the community leaders, teachers, and other enlightened local people.

6. Mr. Mushavanga Tienie was the translator for the both the Omega 1 and Masambo Communities meeting that were organised and requested by Chief Bennie Ngombara, (Chief of the Khwe Traditional Authority).
Table 5.1: Kavango East and West Regions Ministry of Environment, Forestry and Tourism stakeholders consultation and field-based visits/verifications of the proposed 2D seismic survey area and drilling locations undertaken on the 18th and 19th January 2021 (Sanzila, 2021).

<table>
<thead>
<tr>
<th>Date and Time</th>
<th>Meeting Type</th>
<th>Venue</th>
<th># of People</th>
<th>Picture</th>
</tr>
</thead>
<tbody>
<tr>
<td>18th &amp; 19th January 2021</td>
<td>Stakeholders Engagement Meeting with the Ministry of Environment Forestry and Tourism (MEFT).</td>
<td>AMTA Offices, Kavango East Region.</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Field site visit with MEFT to most of the proposed 2D Seismic Survey lines localities already existing access roads.</td>
<td>Site visit Location</td>
<td>Survey line</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ncamagoro</td>
<td>EW4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ncuncuni</td>
<td>EW5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gcaru</td>
<td>NS1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(southern extension)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>EW5</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(western extension)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ncaute, Kawe, Cuma</td>
<td>EW3, NS5, EW1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kawe, Mbambi</td>
<td>(6-1 and 6-2)</td>
<td>Stratigraphic Well construction sites.</td>
</tr>
</tbody>
</table>
Plate 5.22: Ministry of Environment, Forestry and Tourism team during the field familiarisation / inspection visit to the Well No. 5-6 location along the access track linking the D3425 to the B8 tarred Road from Grootfontein to Rundu north of Mangetti National Park. This track is an alternative potential East-West seismic survey line if required.
Plate 5.23: Ministry of Environment, Forestry and Tourism team during the field familiarisation / inspection visit to the southern end of the 2D seismic line NS-1 along the D3425 road near Namkaub.
Table 5.16: Nkurenkuru Kavango West Region formal public meeting (morning and afternoon sessions) held at Nkurenkuru Community Hall on the 20th January 2021 (Sanzila, 2021).

<table>
<thead>
<tr>
<th>Date and Time</th>
<th>Meeting Type</th>
<th>Venue</th>
<th># of People</th>
</tr>
</thead>
<tbody>
<tr>
<td>20th January 2021</td>
<td>Formal Public Meeting (Morning session)</td>
<td>Nkurenkuru, Nkurenkuru Community Hall, Kavango West Region.</td>
<td>49</td>
</tr>
<tr>
<td>10AM - 12PM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20th January 2021</td>
<td>Public Open Day 'walk in' Afternoon session</td>
<td></td>
<td>11 (walk in and out)</td>
</tr>
<tr>
<td>12PM - 18PM</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Table 5.17: Rundu Kavango East Region formal public meeting (morning and afternoon sessions) held at AMTA Rundu on the 22nd January 2021(Sanzila, 2021).

<table>
<thead>
<tr>
<th>Date and Time</th>
<th>Meeting Type</th>
<th>Venue</th>
<th># of People</th>
</tr>
</thead>
<tbody>
<tr>
<td>22nd January 2021</td>
<td>Formal Public Meeting</td>
<td>AMTA, Rundu Kavango East Region.</td>
<td>50</td>
</tr>
<tr>
<td>10AM - 12PM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22nd January 2021</td>
<td>Public Open Day 'walk in' Afternoon session</td>
<td></td>
<td>57 (walk in and out)</td>
</tr>
<tr>
<td>12PM - 18PM</td>
<td></td>
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</tbody>
</table>

Table 5.18: Sivaradi 1 and 2), Kavango West Region formal community meeting held under the community meeting tree on the 23rd January 2021 (Sanzila, 2021).

<table>
<thead>
<tr>
<th>Date and Time</th>
<th>Meeting Type</th>
<th>Venue</th>
<th># of People</th>
</tr>
</thead>
<tbody>
<tr>
<td>23rd January 2021; 11AM-14PM</td>
<td>Community Meeting (under Trees/ Open Spaces)</td>
<td>Ncamagoro Constituency: Sivaradi (including communities from Sivarati 1 &amp; 2).</td>
<td>41 (under Trees/ Open Spaces)</td>
</tr>
</tbody>
</table>
Table 5.19: Gcaru, Kavango West Region formal community meeting held under the community meeting tree on the 23rd January 2021 (Sanzila, 2021).

<table>
<thead>
<tr>
<th>Date and Time</th>
<th>Meeting Type</th>
<th>Venue</th>
<th># of People</th>
<th>Picture</th>
</tr>
</thead>
</table>
| 23rd January 2021; 14PM-18PM | Community Meeting (under Trees/Open Spaces)  
Key Attendees: Traditional Authority including Councilor and Headman. | Gcaru Community including nearby communities  
refer to attendance registers | 59 (under Trees/Open Spaces) | ![Picture](Gcaru Meeting.jpg) |

Table 5.20: Ncuncuni, Kavango West Region formal community meeting held under the community meeting tree on the 25th January 2021 (Sanzila, 2021).

<table>
<thead>
<tr>
<th>Date and Time</th>
<th>Meeting Type</th>
<th>Venue</th>
<th># of People</th>
<th>Picture</th>
</tr>
</thead>
</table>
| 25th January 2021; 11AM-14PM | Community Meeting (under Trees/Open Spaces)  
Key Attendees: Traditional Authority including Councilor and Headman | Ncuncuni Community including nearby communities  
refer to attendance registers | 74 (under Trees/Open Spaces) | ![Picture](Ncuncuni Meeting.jpg) |

Table 5.21: Ncaute, Kavango East/West Regions formal community meeting held under the community meeting tree on the 26th January 2021 (Sanzila, 2021).

<table>
<thead>
<tr>
<th>Date and Time</th>
<th>Meeting Type</th>
<th>Venue</th>
<th># of People</th>
<th>Picture</th>
</tr>
</thead>
</table>
| 26th January 2021; 14PM-18PM | Community Meeting (under Trees/Open Spaces)  
Key Attendees: Traditional Authority including Councilor and Headman. | Ncaute Community and nearby communities  
(refer to attendance registers) | 37 (under Trees/Open Spaces) | ![Picture](Ncaute Meeting.jpg) |
**Table 5.22:** Makandina, Kavango East Region formal community meeting held under the community meeting tree on the 27th January 2021 (Sanzila, 2021).

<table>
<thead>
<tr>
<th>Date and Time</th>
<th>Meeting Type</th>
<th>Venue</th>
<th># of People</th>
</tr>
</thead>
<tbody>
<tr>
<td>27th January 2021</td>
<td>Community Meeting (under Trees/ Open Spaces)</td>
<td>Makandina Community including nearby communities</td>
<td>70 (under Trees/ Open Spaces)</td>
</tr>
<tr>
<td>14PM-18PM</td>
<td>Key Attendees: Traditional Authority including Councilor and Headman.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 5.23:** Windhoek, Khomas Region formal public meeting held Hotel Thule, Windhoek on the 2nd February 2021 organised by ReconAfrica and Namibia Chamber of Environment (Sanzila, 2021).

<table>
<thead>
<tr>
<th>Date and Time</th>
<th>Meeting Type</th>
<th>Venue</th>
<th># of People</th>
</tr>
</thead>
<tbody>
<tr>
<td>2nd February 2021</td>
<td>Public Consultation Meeting (Morning Session)</td>
<td>Hotel Thule, Windhoek</td>
<td>61</td>
</tr>
<tr>
<td></td>
<td>Public Consultation Meeting (Afternoon Session)</td>
<td></td>
<td>32</td>
</tr>
<tr>
<td>Morning and Afternoon Sessions</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 5.24:** Mutwegombahe, Kavango East Region formal community meeting held under the community meeting tree on the 8th February 2021 (Sanzila, 2021).

<table>
<thead>
<tr>
<th>Date and Time</th>
<th>Meeting Type</th>
<th>Venue</th>
<th># of People</th>
</tr>
</thead>
<tbody>
<tr>
<td>8th February 2021</td>
<td>Community Meeting (under Trees/ Open Spaces)</td>
<td>Mutwegombahe Community</td>
<td>27 (under Trees/ Open Spaces)</td>
</tr>
<tr>
<td>10AM-12PM</td>
<td>Key Attendees: Traditional Authority including Councilor and Headman.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 5.25: Mbambi, Kavango East Region formal community meeting held under the community meeting tree on the 8th February 2021 (Sanzila, 2021).

<table>
<thead>
<tr>
<th>Date and Time</th>
<th>Meeting Type</th>
<th>Venue</th>
<th># of People</th>
</tr>
</thead>
<tbody>
<tr>
<td>8th February 2021</td>
<td>Community Meeting (under Trees/ Open Spaces)</td>
<td>Mbambi Community</td>
<td>93</td>
</tr>
<tr>
<td>12PM-14PM</td>
<td>Key Attendees: Traditional Authority including Councilor and Headman.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5.26: Cuma Kavango East Region formal community meeting held under the community meeting tree on the 8th February 2021 (Sanzila, 2021).

<table>
<thead>
<tr>
<th>Date and Time</th>
<th>Meeting Type</th>
<th>Venue</th>
<th># of People</th>
</tr>
</thead>
<tbody>
<tr>
<td>8th February 2021</td>
<td>Community Meeting (under Trees/ Open Spaces)</td>
<td>Cuma Community</td>
<td>50</td>
</tr>
<tr>
<td>16PM-18PM</td>
<td>Key Attendees: Traditional Authority including Councilor and Headman.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 5.27: San Community formal community meeting held on the 18th March 2021 under the community meeting tree at Omega 1 covering, Chetta, Mangarangandja, Mutijku, Mushashani and Mshasho Villages in Bwabwata National Park, Western Zambezi Region (Sanzila, 2021).

<table>
<thead>
<tr>
<th>Date and Time</th>
<th>Meeting Type</th>
<th>Venue</th>
<th># of People</th>
<th>Picture</th>
</tr>
</thead>
<tbody>
<tr>
<td>18th March 2021</td>
<td>Community Meeting (under Trees/ Open Spaces) Key Attendees: Traditional Authority and Headman.</td>
<td>Omega 1 covering, Chetta, Mangarangandja, Mutijku, Mushashani and Mshasho Villages in Bwabwata National Park, Western Zambezi Region</td>
<td>51</td>
<td></td>
</tr>
</tbody>
</table>

Table 5.28: San Community formal community meeting held on the 18th March 2021 under the community meeting tree at Masambo, covering Poca, Omega 3, Chetto, Muteik, Pipo and Ionxei villages in Bwabwata National Park, Western Zambezi Region, (Late Afternoon Sessions (Sanzila, 2021)).

<table>
<thead>
<tr>
<th>Date and Time</th>
<th>Meeting Type</th>
<th>Venue</th>
<th># of People</th>
<th>Picture</th>
</tr>
</thead>
<tbody>
<tr>
<td>18th March 2021</td>
<td>Community Meeting (under Trees/ Open Spaces) Key Attendees: Traditional Authority including and Headman.</td>
<td>Masambo, covering Poca, Omega 3, Chetto, Muteik, Pipo and Ionxei villages in Bwabwata National Park, Western Zambezi Region, 18th March 2021, (Late Afternoon Sessions</td>
<td>61</td>
<td></td>
</tr>
</tbody>
</table>
Plate 5.24: Delivering community meetings in Kavango West and East regions using posters, and simplified physical illustrations and local landscapes such as the Omatako Ephemeral River Channels, a camping mattress, dumbbells, plumbing pipes, and an actual drill core to illustrate to the local communities the various aspects of oil and gas exploration with special focus on 2D seismic survey operations (Sanzila, 2021).
Printed handouts of the key components and equipment of the proposed project activities were provided at the community meetings in Kavango West and East regions in addition to the posters, and physical simple illustrations and local landscape examples (Sanzila, 2021).
5.7.4 Discussion of Issues Raised and Meetings and Stakeholder Submissions

Minutes of all the stakeholders, public and community meetings are provided in Annex 3. Written submissions made by various Interested and Affected Parties (I&APs) are also provided in Annex 3 with responses provided where applicable and relevant to the proposed 2D seismic survey. All the inputs, comments and submissions have all been reviewed, evaluated and have been incorporated in the EIA process where relevant and applicable to the proposed scope of work (Proposed 2D seismic Survey operations).

The following is the summary of the key issues that have been raised with detailed answers provided in the Annex 3 as may be applicable to the proposed 2D seismic survey operations:

1. Petroleum exploration (2D seismic and stratigraphic well drilling) and the associated environmental and social impacts.
2. Social aspects (socio-economic benefits from 2D seismic and stratigraphic well drilling).
3. Social aspects (employment and recruitment process).
4. Social aspects (training).
5. The Kavango Sedimentary Basin.
6. 2D seismic survey and or stratigraphic well drilling activities.
7. 2D seismic survey activities potential impacts associated with community forests.
8. 2D Seismic survey activities and or existing oil & gas stratigraphic well drilling activities potential impacts to land owners.
9. Media backflash.
11. Petroleum agreement.
12. EIA process for the proposed 2D seismic survey.
14. Need for a Strategic Environmental Assessment (SEA) instead of an EIA.
15. Safety of the proposed 2D Seismic survey operations on local infrastructure.
16. Objectivity of the EIA Process and qualifications of Dr Sindila Mwiya, and.
17. Claims on limited community consultation process undertaken.

Overall, key concerns from the Kavango East and West Regions public and stakeholders consultations meetings were centred on local socioeconomic issues and any likely local benefits to be derived from the proposed project activities. Despite the current activities being short-term exploration operations, ReconAfrica has committed to employing local people, work with local communities and uplift the lives of the local community through Corporate Social Responsibility (CSR) with special focus on rural water supply. The company has committed to implementing a community water wells programme by drilling community water wells at each of the locations where the company will be drilling a stratigraphic well. One such well has already been handed over to the community of Mutwegombahe near Kawe where the Proponent is currently drilling the first stratigraphic well (Plate 3.5).
Most of the questions and comments raised had less to do with the EIA process for the proposed 2D Seismic survey activities but rather the already approved and ongoing Stratigraphic Wells drilling programme with irrelevant claims on fracking, or hydraulic fracturing currently being conducted by ReconAfrica. Fracking is used to produce or extract commercially discovered oil or gas or even water. It relates to Production License not an Exploration License that ReconAfrica is currently holding as granted by the Competent Authority, the Ministry of Mine and Energy.

ReconAfrica holds a Petroleum Exploration License (PEL) No. 73 and this license is for exploration not for producing oil or gas through fracking. Furthermore, ReconAfrica’s Crown 750 drilling rig is a relatively small rig designed for mobility and drilling conventional wells only. The rig is truck mounted and designed for light impact and mobility across desert conditions. With 1000 HP the Crown 750 can drill to about 4000m depth which restricts operations to vertically drilled conventional formations only.

As for the proposed 2D seismic survey operations, it will be conducted along existing roads and tracks and the whole operations will last for a limited period. The reason for conducting the seismic survey is to search for suitable traps or geological structures that may hold economic oil or gas reserves within the sedimentary basin confirmed by the stratigraphic drilling results. If the seismic survey finds a potential suitable geological structure, a separate ECC will be required before the company can conduct exploration well drilling operations. If the exploration well drilling proves positive that means oil or gas is discovered, again, a separate ECC for appraisal / evaluation well drilling operations will be required. If, and this really if, economic oil or gas is discovered following the appraisal drilling operations, then a final ECC for production process inclusive of the supporting infrastructures that could be a pipeline, refinery, or Power Station (if it is gas that is found) will be required.

The proposed 2D Seismic survey has been undertaken in Namibia and other parts of the World and proven not to affect any local infrastructures such as shallow water wells or houses. The technology to be used in the proposed 2D seismic survey is well proven and will not use dynamite which is associated with shot holes residues remains that might contaminate local waters resources over time.

This EIA process to support the application for ECC for the proposed 2D seismic survey operation has been conducted by independent, appropriately qualified and highly experienced team of consultants. The team has been led by Dr Sindila Mwiya who is an independent consultant, highly qualified and experienced Engineering and Environmental Geologist. He has more than eighteen (18) years of experiences, has conducted more 200 EIAs since 2004 and hold a PhD with research interests, academic training and knowledge in Engineering Geology / Geotechnical / Geoenvironmental / Environmental Engineering, Artificial Intelligence and Knowledge-Based Systems with special focus on EIAs, EMPs, EMSs, SEAs and SEMPs for subsurface resources (minerals, petroleum, water) and energy in Arid and Semiarid Environments.

The following is the summary of key independent specialist consultants who have contributed to the compilation of this EIA Report and the CVs are provided in Annex 4:

(i) Mr. Peter Cunningham ‒ Flora and Fauna.
(ii) Mr. Ashley Julius ‒ Water Resources (Geology, Hydrology and Hydrogeology).
(iii) Dr Vita Stankevica ‒ Socioeconomic.
(iv) Dr Alma Nankela, Archaeologist on Quaternary and Prehistorian.
(v) Dr Onjefu Sylvanus Ameh- Environmental, Aerosol, Noise, Radiation and Occupation and Safety Consultant, and.
(vi) Mr. Marvin Sanzila ‒ Public and Stakeholder Consultation and Engagement consultant.
6. IMPACT ASSESSMENT

6.1 Assessment Procedure


The overall impact assessment adopted the Leopold matrix framework which is one of the internationally best-known matrix assessment methodology available for predicting the impact of a project on the receiving environment. The assessment process took into considerations the proposed activities, trade-offs, alternatives, and issues to be considered. Further inputs were provided by specialist consultants.

6.2 Alternatives to the Proposed Project Activities (2D seismic Survey)

The alternatives that have been considered covers the activities of the proposed seismic survey method, not the energy sector/s (non-renewable and renewable sources) as alternatives. The following alternatives with respect to the proposed 2D seismic survey method have been considered as part of the assessment process:

(i) **Survey location with respect to the PEL and Areas of Interest (AOI):** The targeted areas of interest (potential sedimentary basin areas) are site-specific and related to the regional and local geology and petroleum system of a specific area to which there are no alternatives sites to consider with respect to the license area. Based on the results of the ongoing exploration efforts, the various areas of interest will be evaluated and ranked accordingly.

(ii) **Profiles / survey lines kms length, roads, and tracks to be used:** The proposed 2D seismic survey operations will be undertaken along north-south and east west oriented existing roads and tracks. Several alternative roads and tracks have been identified and exists within the survey area. Such alternative survey lines identified include: Access track linking the D3425 to the B8 tarred Road from Grootfontein to Rundu north of Mangetti National Park as an alternative to any East-West line and the road from Taratara to the D3400 junction recommended as the alternative survey line for the EW-2 eastern section. Several community tracks, paths, unused cleared, and disturbed areas that could be used as alternative survey lines / offsets to the survey lines exists throughout the proposed survey area.

(iii) **Energy source (Vibroseis, Explorer 860 or Dynamite):** Detailed comparative assessment on the use of vibroseis, dynamite or Explorer 860 for the proposed 2D seismic operations in PEL 73 has been undertaken. The Explorer 860 has been selected because it provides impressive peak force, excellent frequency content with high productivity and minimal environmental impact with a single unit per source point (3 units on project), 860,000 lbs. of adjustable force, faster than vibroseis, zero phase data same as dynamite, closest operating limits to infrastructure and perfect for high density population and environmentally sensitive areas, patented source technology, very fast 10 seconds between pops and typically 3-4 pops per Source Point (SP) and very high fold capability.

(iv) **Receivers / Geophones (Wireless or Cabled):** Latest wireless geophones / receivers / recorders will be used in the proposed 2D seismic survey instead of cabled old technology system. The proposed survey will use the STRYDE recording technology which represents the latest, smallest, and most easily deployable system on the market with a wider lines offsets that does not require extensive vegetation clearing, scales to thousands of channels, flexibility to deploy over demanding terrains, higher productivity with no downtime for cable repairs, reduced crew and transportation costs, small footprint, improved safety, and reduced risk of injury.
(v) **The No-Action Alternative** - A comparative assessment of the environmental impacts of the no-action alternative (a future in which the proposed 2D seismic survey activities do not take place) has been undertaken. An assessment of the environmental impacts of a future, in which the proposed seismic survey does not take place, may be good for the receiving environment because there be no negative environmental impacts due to proposed activities that will take place in the area. The environmental benefits will include no negative environmental impacts on the receiving environment. However, it is important to understand that even if the proposed exploration activities do not take place, to which the likely negative environmental impacts are likely to be low and localised, the current and other future land uses will still have some negative impacts on the receiving environment.

The likely negative environmental impacts of other current and future land use that may still happen in the absence of the proposed 2D seismic survey activities includes: Land degradation due to drought, deforestation due to poor land management practices (slash and burn farming practices), timber harvesting, new communal land allocations, new homesteads and field clearing due increasing population, wild and manmade fires, erosion, and overgrazing. Furthermore, it is also important to understand what benefits might be lost if the proposed exploration activities do not take place. Key loses that may never be realised if the proposed project activities do not go-ahead include: Loss of potential added value to the unknown underground potential subsurface resources such as petroleum, minerals, water, other energy sources that may be found within the PEL No. 73 using the proposed 2D seismic survey data to be generated, socioeconomic benefits derived from current and future exploration capital investments, current license rental fees, current contributions to training of Namibians, direct and indirect contracts and employment opportunities, foreign direct investments and various taxes payable to the Government of Namibia.

(vi) **Land Uses and Conflicts:** The proposed survey area falls within the sparsely populated communal land of the Kavango West and East Regions. Communal subsistence agricultural land uses area dominated by stock and seasonal crop farming practices. Conservancies and several community forests exist in the area with existing roads and tracks cutting across these areas. Due to the limited scope of the proposed 2D seismic survey operations centred around the existing roads and tracks, it is likely that the proposed activities will coexist with the current land and future uses in the area.

(vii) **Ecosystem Function (What the Ecosystem Does):** Ecosystem functions such as wildlife habitats, carbon cycling or the trapping of nutrients and characterised by the physical, chemical, and biological processes or attributes that contribute to the self-maintenance of an ecosystem in this area are vital components of the receiving environment. The proposed 2D seismic survey activities are not likely to affect the ecosystem function due to the limited scope and duration centred around the existing roads and tracks.

(viii) **Ecosystem Services:** Food chain, harvesting of animals or plants, and the provision of clean water or scenic views are some of the local ecosystem services associated with the proposed project area. The proposed 2D seismic survey activities will not affect the ecosystem services due to the limited scope and duration centred around the existing roads and tracks.

(ix) **Use Values:** The proposed project area has direct values for other land uses such as agriculture, conservation, and tourism as well as indirect values which includes: Watching a television show about the general area and its wildlife, food chain linkages that sustains the complex life within this area and bequest value for future generations to enjoy. The proposed 2D seismic survey activities will not destroy the current use values because the activities will be centred around the existing roads and tracks.

(x) **Non-Use or Passive Use:** The proposed project area has an existence value that is not linked to the direct use / benefits to current or future generations. The proposed 2D seismic survey operations will not affect the ecosystem current or future none or passive uses due to the limited scope of the proposed activities that might leave much of the project area untouched because the activities will be centred around the existing roads and tracks targeting potential deep-seated (averaging 4 km deep) subsurface potential geological structures.
6.3 Impact Assessment Criteria

6.3.1 Evaluation of Impacts

Sources of potential positive or negative impacts and the sensitivity of the receiving environment have all be evaluated as part of the impact assessment process for the proposed 2D seismic survey operations. For each negative impact of high or medium significance, mitigation objectives are set (i.e. ways of reducing negative impacts), and attainable management actions are subsequently addressed in the EMP. Without management, these impacts would either breach statutory limits or be unacceptable to statutory authorities or to stakeholders, as they would result in a significant deterioration of one or more environmental resources or component of the receiving environment.

6.3.2 Environmental Impact Assessment Rankings

To ensure consistency in the evaluation of environmental impacts associated with the proposed 2D seismic survey operations, the rating criteria for the impact assessment have been standardised to include a set definitions applied in the risk assessment (Table 6.1). To the extent possible, allocation to rank categories is based on quantifiable criteria which can be measured as detailed in Table 6.1. Furthermore, when evaluating impacts, the allocated ranks refer to the resultant impact (e.g. habitat area affected, or time that the result of the impact will last), and not of the cause thereof (e.g. time of active impact). Each activity has been assessed with respect to the type of effect that the aspect will have on the relevant component of the environment and includes what will be affected and how? The criteria used to determine the significance rating of the impact(s) is detailed in Table 6.2.

Table 6.1: Definition of impact categories.

<table>
<thead>
<tr>
<th>Rating</th>
<th>Definition of Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status of the Impact – in terms of meeting the objective of maintaining a healthy environment.</td>
<td></td>
</tr>
<tr>
<td>Positive</td>
<td>The impact benefits the environment</td>
</tr>
<tr>
<td>Negative</td>
<td>The impact results in a cost to the environment</td>
</tr>
<tr>
<td>Neutral</td>
<td>The impact has no effect</td>
</tr>
<tr>
<td>Probability – the likelihood of the impact occurring</td>
<td></td>
</tr>
<tr>
<td>Negligible</td>
<td>Possibility negligible</td>
</tr>
<tr>
<td>Improbable</td>
<td>Possibility very low</td>
</tr>
<tr>
<td>Probable</td>
<td>Distinct possibility</td>
</tr>
<tr>
<td>Highly Probable</td>
<td>Most likely</td>
</tr>
<tr>
<td>Definite</td>
<td>Impact will occur regardless of preventive measures</td>
</tr>
<tr>
<td>Degree of confidence in predictions – in terms of basing the assessment on available information</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>Assessment based on extrapolated data</td>
</tr>
<tr>
<td>Medium</td>
<td>Information base available but lacking</td>
</tr>
<tr>
<td>High</td>
<td>Information base comparatively reliable</td>
</tr>
<tr>
<td>Extent – the area over which the impact will be experienced</td>
<td></td>
</tr>
<tr>
<td>Site specific</td>
<td>Confined to within &lt; 1 km of the project</td>
</tr>
<tr>
<td>Local</td>
<td>Confined to the study area or within 5 km of the project</td>
</tr>
<tr>
<td>Regional</td>
<td>Confined to the region, i.e. &gt; 5 km but &lt; National</td>
</tr>
<tr>
<td>National</td>
<td>Nationally</td>
</tr>
<tr>
<td>International</td>
<td>Beyond the borders of Namibia</td>
</tr>
<tr>
<td>Duration – the time frame for which the impact will be experienced</td>
<td></td>
</tr>
<tr>
<td>Very short</td>
<td>Less than 2 years</td>
</tr>
<tr>
<td>Short-term</td>
<td>2 to 5 years</td>
</tr>
<tr>
<td>Medium-term</td>
<td>6 to 15 years</td>
</tr>
<tr>
<td>Long-term</td>
<td>More than 15 years</td>
</tr>
<tr>
<td>Permanent</td>
<td>Generations</td>
</tr>
<tr>
<td>Intensity – the magnitude of the impact in relation to the sensitivity of the receiving environment</td>
<td></td>
</tr>
<tr>
<td>Negligible</td>
<td>Natural functions and processes are negligibly altered due to adaptation by the receptor(s) to high natural environmental variability</td>
</tr>
<tr>
<td>Mild</td>
<td>Natural functions and processes continue albeit in a modified way that does not appear to have a significant disruptive effect (i.e. changes are temporary)</td>
</tr>
<tr>
<td>Moderate</td>
<td>Natural functions and processes continue albeit in a modified way that does appear to have a noticeable disruptive effect (i.e. changes are permanent)</td>
</tr>
<tr>
<td>Severe</td>
<td>Natural functions or processes are altered to the extent that they temporarily cease resulting in severe deterioration of the impacted environment</td>
</tr>
<tr>
<td>Very Severe</td>
<td>Natural functions or processes permanently cease or are completely disrupted</td>
</tr>
</tbody>
</table>
Table 6.2: The criteria used to determine the significance rating of the impact(s).

<table>
<thead>
<tr>
<th>Low</th>
<th>Where the impact will have a negligible influence on the environment and no modifications or mitigations are necessary for the given project description. This would be allocated to impacts of any severity/magnitude, if at a local scale/extent and of temporary duration/time.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medium</td>
<td>Where the impact could have an influence on the environment, which will require modification of the project design and/or alternative mitigation. This would be allocated to impacts of moderate severity, locally to regionally, and in the short term.</td>
</tr>
<tr>
<td>High</td>
<td>Where the impact could have a significant influence on the environment and, in the event of a negative impact, the activity(ies) causing it should not be permitted without substantial mitigation and management, and pro-active rehabilitation commitments (i.e. there could be a ‘no-go’ implication for the project). This would be allocated to impacts of severe magnitude, locally over the medium-term, and/or of severe magnitude regionally and beyond.</td>
</tr>
</tbody>
</table>

6.4 Identification of Likely Impacts

6.4.1 Likely Sources Impacts

This Environmental Assessment process has taken into consideration the sensitivity of the receiving environment (physical, biological, socioeconomic and ecosystem) with respect to the proposed 2D seismic survey operations. The following is the summary of the likely sources of negative impacts on the receiving environment that have been evaluated during the EIA process:

(i) Planning and mobilisation (Pre-survey preparation).

(ii) Camp sites setups and widening of tracks and creation of limited new access as may be applicable.

(iii) Actual data acquisition, and.

(iv) Demobilisation and Closure (Survey Completion).

6.4.2 Likely Positive Impacts

6.4.2.1 Summary of Likely Positive Impacts

Based on the results of the EIA report, the following is the summary of the key positive impacts that the proposed 2D seismic survey will have:

- Payment of the annual license rental fees to the Central Government averaging N$2 million per year and this is vital revenue streams for the State paid by all petroleum exploration companies in Namibia and for the benefit of all Namibians.

- USD50, 000.00 annual contributions to the Petroleum Training and Education Fund (PETROFUND) paid by all petroleum exploration companies in Namibia. The PetroFund provides local regional and international bursaries and scholarships to seventy (70) Namibians annually.

- Short-term contractual employment opportunities (3-4 months) for the local communities during the survey operations.

- Expansion of the subsurface knowledge-base: The seismic survey data to be generated will be highly useful in the search for other subsurface resources such as minerals, water, geothermal and general geoscience research, and development, and.

- Contribution to the development of local infrastructures such as rural water supply through Corporate Social Responsibility (CSR) that the Proponent is current supporting in Kavango East Region.
Tables 6.3 - 6.7 summarises the impact assessment results associated with positive impacts linked to the socioeconomic benefits covering payment of license fees, training contribution to the PetroFund employment, improved social services, training and skills transfer and boost to local economies.

Table 6.3: Continue with the payment of the annual license rental fees to the central Government.

<table>
<thead>
<tr>
<th>Continued contribution to local, regional, and national economy through payment of the annual license rental fees to the Central Government averaging N$2 million per year and this is vital revenue streams for the State paid by all petroleum exploration companies in Namibia and for the benefit of all Namibians</th>
<th>Status</th>
<th>Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability</td>
<td>Definite</td>
<td></td>
</tr>
<tr>
<td>Confidence</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Extent</td>
<td>National</td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>Short-term</td>
<td></td>
</tr>
<tr>
<td>Intensity</td>
<td>Moderate</td>
<td></td>
</tr>
<tr>
<td>Significance</td>
<td>High</td>
<td></td>
</tr>
</tbody>
</table>

Table 6.4: Continue with annual contributions to the Petroleum Training and Education Fund (PetroFund).

<table>
<thead>
<tr>
<th>Continue with USD50, 000.00 annual contributions to the Petroleum Training and Education Fund (PETROFUND) paid by all petroleum exploration companies in Namibia. The PetroFund provides local regional and international bursaries and scholarships to seventy (70) Namibians annually</th>
<th>Status</th>
<th>Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability</td>
<td>Definite</td>
<td></td>
</tr>
<tr>
<td>Confidence</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Extent</td>
<td>National</td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>Medium-Term</td>
<td></td>
</tr>
<tr>
<td>Intensity</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Significance</td>
<td>Medium</td>
<td></td>
</tr>
</tbody>
</table>

Table 6.5: Provisions of short-term contractual employment opportunities.

<table>
<thead>
<tr>
<th>Short-term contractual employment opportunities (3-4 months) for the local communities during the proposed 2D seismic survey operations</th>
<th>Status</th>
<th>Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability</td>
<td>Definite</td>
<td></td>
</tr>
<tr>
<td>Confidence</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Extent</td>
<td>National; Employees are mostly from Namibia, with fewer from other countries such as Canada.</td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>Very short</td>
<td></td>
</tr>
<tr>
<td>Intensity</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Significance</td>
<td>High; a significant number of especially rural families in Kavango West and East will benefit in terms of short-term employment and wages.</td>
<td></td>
</tr>
</tbody>
</table>

Table 6.6: Expansion of the subsurface national knowledge-base.

<table>
<thead>
<tr>
<th>The seismic survey data to be generated will be highly useful in the search for other subsurface resources such as minerals, water, geothermal and general geoscience research, and development</th>
<th>Status</th>
<th>Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability</td>
<td>Definite</td>
<td></td>
</tr>
<tr>
<td>Confidence</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Extent</td>
<td>National</td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>Long-term</td>
<td></td>
</tr>
<tr>
<td>Intensity</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Significance</td>
<td>High</td>
<td></td>
</tr>
</tbody>
</table>
Table 6.7: Support to the development of rural water supply and other local infrastructure through Corporate Social Responsibility (CSR).

<table>
<thead>
<tr>
<th>Contribution to the development of local infrastructures such as rural water supply through Corporate Social Responsibility (CSR) that the Proponent is currently supporting in Kavango East Region</th>
<th>Status</th>
<th>Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Probability</strong></td>
<td></td>
<td>Definite</td>
</tr>
<tr>
<td><strong>Confidence</strong></td>
<td></td>
<td>High</td>
</tr>
<tr>
<td><strong>Extent</strong></td>
<td></td>
<td>Local</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td></td>
<td>Permanent</td>
</tr>
<tr>
<td><strong>Intensity</strong></td>
<td></td>
<td>High</td>
</tr>
<tr>
<td><strong>Significance</strong></td>
<td></td>
<td>High</td>
</tr>
</tbody>
</table>

6.4.2.2 Summary of Likely Positive Cumulative Impacts

Positive cumulative benefits for the country and local community will be derived from the continued procurement of goods, equipment, and professional services by the Proponent in addition to other businesses using the same services. Local community semi-skilled workers who may be employed in the proposed 2D seismic survey will likely acquire new and lifelong skills that may prove useful in other sectors of the Namibian economy. The implementation of the proposed 2D seismic survey will guarantee positive impacts through continued contributions by ReconAfrica to the PetroFund and payment of license rental fees in addition to the contributions by other oil and gas exploration companies operating in Namibia. Additional, short-term contracts and employment opportunities will be guaranteed in addition to all other opportunities being offered by other companies in Namibia and in Kavango West and East Regions. Table 6.8 summarises the results of the positive cumulative impact assessment with respect to the proposed 2D seismic.

Table 6.8: Likely positive cumulative impacts.

<table>
<thead>
<tr>
<th>Status</th>
<th>Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Probability</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Confidence</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Extent</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Intensity</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Significance</strong></td>
<td></td>
</tr>
</tbody>
</table>

6.3.2 Description of Likely Negative Impacts of the Proposed 2D Seismic Survey

6.3.2.1 Summary of Likely Negatively Impacts

Based on the finding of this EIA Process, the following is the summary of the key likely negative environmental impacts that the proposed activities may have on the receiving environment:

1. Disruption / disturbance of the habitats.
2. Reptiles.
3. Amphibian.
5. Avian.
6. Tree and shrub species.
7. Grass.
8. Socioeconomic environment.
10. Ecosystem functions, services, use values and non-use or passive use.
11. Physiography and geology.
13. Surface and groundwater quality.
14. Increased water consumption / depletion of water resources.
15. Existing local community water supply infrastructure along the proposed survey lines (existing roads and tracks).
17. Noise and vibrations.
18. Dust and air quality.
19. Waste (solid and liquid) management.
20. Accidental events.
21. Archaeological, paleontological, and historical resources.
22. Contributions to global Climate Change, and.
23. Cumulative impacts.

The above listed likely sources of negative impacts have been evaluated during the EIA for the proposed for the proposed 2D seismic survey operations in PEL 73 with mitigation measures provided in the separate EMP Report.

6.3.2.2 Likely Negative Impacts on the Disruption / Disturbance of the Habitats

The most important areas in the general surrounding areas of PEL 73, areas of interest and proposed 2D seismic survey areas are:

1. KAZA TFCA which is a multiple land use regional transboundary conservation initiative with a common vision of promoting and supporting sustainable livelihoods through coexistence and utilisation of multiple resource and resources areas including national parks, game reserves, forest reserves, conservancies, game/wildlife management areas and communal lands livelihoods that are dependent on seasonal subsistence agriculture, animal husbandry, fishing, natural resource harvesting, tourism, trading and hunting. Within KAZA TECA, there are also vital subsurface resources such as water, minerals, geothermal energy, and petroleum that are unfortunately not mentioned under KAZA vision. The overall vision is still a working progress because the assumed beneficiaries who are the local communities continues to languish in poverty on the doorsteps of KAZA, as seen around the current areas of operations such as Kawe and Ncaute and many parts of Kavango East and Zambezi Regions that are supposed to be thriving within the boundary of KAZA TFCA. The tourism benefits in the name of KAZA TFCA are in hands of international, regional, and national connected operators and NGOs and it remain to be seen when such benefits will start making some positive socioeconomic impacts on the lives of most of the rural communities and if this will ever happen. Sensitive areas within the Namibian portion of KAZA TFCA are known and the Areas of Interest (AOI) and the proposed 2D seismic survey operations in PEL 73 do not fall in such sensitive area such as a
national park, legally excluded from oil and gas exploration in Namibia and current operations have no negative environmental consequence on KAZA TFCA because the operations covers communal lands and the proposed 2D seismic survey will utilise already existing roads and tracks.

2. The Okavango River is viewed as a site of special ecological importance in Namibia due to its biotic richness, threatened plants and insects (Curtis and Barnard 1998). The Okavango river area is not part of the area of interest and proposed 2D seismic survey will not be conducted near this river.

3. Ephemeral Omuramba Omatako Ephemeral rivers viewed as sites of special ecological importance in Namibia due to its biotic richness, large mammals, high value for human subsistence and tourism (Curtis and Barnard 1998). Unfortunately, the general area has been heavily degraded by subsistence agriculture and survey will be conducted in existing roads and tracks.

4. Ephemeral pans are viewed as sites of special ecological importance in Namibia due to its biotic richness, endemic crustacean, Red Data birds, habitat and resource for humans and wildlife (Curtis and Barnard 1998). Although important larger pans such as Nyae Nyae, etc. fall outside the general area, all other smaller pans are also viewed as important habitat.

5. The Kaudum National Park falls within the North-Eastern Kalahari Woodlands vegetation type with omurambas which act as ideal routes for wildlife. Dominant trees include: *Acacia erioloba*, *Adansonia digitata*, *Baikiaea plurijuga*, *Combretum imberbe*, *Guibourtia coleosperma* and *Spirostachys africana*. Important wildlife includes: African wild dog, leopard, lion, spotted hyaena, side-striped jackal, elephant, giraffe, blue wildebeest, eland, kudu, oryx, red hartebeest reedbuck, roan, tsessebe and warthog. Important birds include: Abdim’s stork, African golden oriole, African hobby falcon, Bradfield’s hornbill, ground hornbill, lesser spotted eagle, racket-tailed roller, steppe eagle and yellow-billed kite (www.met.gov.na), and. The Kaudum National Park is excluded from PEL 73.

6. The Mangetti National Park falls within the North-Eastern Kalahari Woodlands vegetation type with the vegetation on the dune crests markedly different to that in dune valleys i.e. Kalahari woodland vegetation dominates the dune crests, whereas mixed acacia savannah vegetation characterises the dune valleys. Dominant trees include: *Acacia erioloba*, *Acacia mellifera*, *Combretum collinum*, *Commiphora species*, *Schinziophyton rautanenii* and *Terminalia sericea*. Important wildlife includes: African wild cat, leopard, spotted hyaena, blue wildebeest, common duiker, kudu, oryx, sable, steenbok and occasional elephant and wild dog. Important birds include: bateleur, lapped-faced vulture, tawny eagle, Meyer’s parrot and striped kingfisher (www.met.gov.na). The Mangetti National Park is excluded from PEL 73.

Overall, the actual key areas of interest which are potential sedimentary basins covering the Kavango West and East Regions being explored by ReconAfrica are situated about 55 km south of Rundu, 80 km south of the Okavango River, more than 260 km from the Okavango Delta in Botswana, more than 40 km from the boundary of the Kaudum National Park and more than 70 km from the Mangetti National Park. The overall general areas of interest covering the Kavango West and East Regions will have no influence on the ecology and environment of the national parks, Okavango River and other sensitive areas including the Okavango Delta in Botswana.

Habitat destruction, due to the creation and widening of new tracks, is more important although the actual footprint is small. However, no new tracks are envisaged and all seismic activity will be conducted along existing roads and tracks throughout the area (Table 6.9).

This would thus not lead to additional habitat disturbances and increased access into areas currently not as easily accessible which could lead the disruption / disturbance of the habitats within survey lines and surrounding areas (Table 6.9).
6.3.2.3 Likely Negative Impacts on Reptiles

The most important species are viewed as those with some form of conservation status (Namibian and International) with the tortoises, pythons and monitor lizard probably the most important groups of reptiles in the general area. Tortoises and the monitor lizard are often killed for food or succumb as road kills while snakes are killed for various reasons often on sight. The 2 endemics (*Ichnotropis grandiceps* and *Lygodactylus bradfieldi*), 3 species classified as rare (*Lycophidion multimaculatum*, *Psammophis jallae*, *Causus rhombeatus*) and 6 species classified as vulnerable (*Stigmochelys pardalis*, *Psammobates oculiferus*, *Kinixys spekii*, *Python natalensis*, *Varanus albigularis*, *Varanus niloticus*) are viewed as the most important species in the general area.

The 2 species classified as data deficient by the IUCN (2020) – *Pelusios (bechuanicus) upembae* and *Ichnotropis grandiceps* – are also viewed as important although *P. upembae* would be associated with the Okavango River system only and not in the survey or area of interest. Since reptiles are an understudied group of animals, especially in Namibia, it is expected that more species may be located in the general area than presented in Annex 2. The general area has been heavily impacted in places, especially along the Omuramba Omatako and areas close to towns and settlements such as Rundu and Ncaute, etc., due to subsistence farming and logging activities and none of the unique reptiles are expected to be exclusively associated with the seismic survey lines. The proposed mitigations are expected to minimise the overall effect on reptiles potentially occurring in the area.

A typical weight drop would have a peak force output of 860,000lbs (~430,000kg) at baseplate with an impulse frequency of 300Hz and a maximum cycle time of 10 seconds (Explorer 860 technical overview). Monk *et al.* (2004) indicates that although some compaction of the soil surface occurs, there is little or no long-term damage to the surface. Although the precise impact of using this technology on reptile fauna is unknown, disturbances would be of short duration and it is not expected that the ground seismic survey, using weight drop technology, will have any lasting negative impacts on reptiles in the general area (Table 6.10).

Habitat destruction, due to the creation and widening of new tracks, is more important although the actual footprint is small. However, no new tracks are envisaged and all seismic activity will be conducted...
along existing roads and tracks throughout the area. This would thus not lead to additional habitat disturbances and increased access into areas currently not as easily accessible which could lead to increased mortalities (e.g., vehicle mortalities and killing of perceived dangerous species such as snakes) and illegal collection of reptiles as food (e.g., tortoises and monitor lizards), etc. The results of the likely negative impacts of the proposed 2D seismic survey on reptiles and their associated habitats are summarised in Table 6.10.

Table 6.10: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on reptiles.

<table>
<thead>
<tr>
<th>Status</th>
<th>Negative</th>
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<tbody>
<tr>
<td>Probability</td>
<td>Improbable</td>
</tr>
<tr>
<td>Confidence</td>
<td>High</td>
</tr>
<tr>
<td>Extent</td>
<td>Site-specific</td>
</tr>
<tr>
<td>Duration</td>
<td>Very Short; for duration of the survey</td>
</tr>
<tr>
<td>Intensity</td>
<td>Mild</td>
</tr>
<tr>
<td>Significance</td>
<td>Medium to Low</td>
</tr>
</tbody>
</table>

6.3.2.4 Likely Negative Impacts on Amphibian

The most important species from the area is the giant bullfrog (*Pyxicephalus adspersus*) with populations decreasing according to the IUCN (2020) as it is consumed as food throughout its range (Griffin *pers. com.*). Most amphibians are expected to be associated with the Okavango River system in the area rather than the sandy interior, although the ephemeral Omuramba Omatako and pans throughout the general area would also be suitable habitat. The general area has been heavily impacted in places, especially along the Omuramba Omatako and areas close to towns and settlements such as Rundu and Ncaute, etc., due to subsistence farming and logging activities and none of the unique amphibians are expected to be exclusively associated with the seismic survey routes. The proposed mitigations as detailed in the EMP Report are expected to minimise the overall effect on amphibians potentially occurring in the area.

Habitat destruction, due to the creation and widening of new tracks, especially through the Omuramba Omatako (and other ephemeral drainage lines), is more important although the actual footprint is small. However, no new tracks are envisaged and all seismic activity will be conducted along existing roads and tracks throughout the area. This would thus not lead to additional habitat disturbances and increased access into areas currently not as easily accessible which could lead to increased mortalities (e.g. vehicle mortalities) and illegal collection of amphibians as food (e.g. giant bullfrog), etc. The results of the likely negative impacts of the proposed 2D seismic survey on amphibians and their associated habitats are summarised in Table 6.11.

Table 6.11: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on amphibian.

<table>
<thead>
<tr>
<th>Status</th>
<th>Negative</th>
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<tbody>
<tr>
<td>Probability</td>
<td>Improbable</td>
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<tr>
<td>Confidence</td>
<td>High</td>
</tr>
<tr>
<td>Extent</td>
<td>Site-specific</td>
</tr>
<tr>
<td>Duration</td>
<td>Very Short; for duration of the survey</td>
</tr>
<tr>
<td>Intensity</td>
<td>Mild</td>
</tr>
<tr>
<td>Significance</td>
<td>Medium to Low</td>
</tr>
</tbody>
</table>

6.3.2.5 Likely Impacts on Mammals

The most important species from the general area are probably those classified as rare (*Nycteris hispida, Kerivoula argentata, Kerivoula lanosa, Mastomys shortridgei, Civittictis civetta, Paracynictis*...
The general area has been heavily impacted in places, especially along the Omuramba Omatako and areas close to towns and settlements such as Rundu and N'caute, etc., due to subsistence farming and logging activities and none of the unique mammals are expected to be exclusively associated with the seismic survey routes. The proposed mitigations as presented in the EMP Report are expected to minimise the overall effect on mammals potentially occurring in the area (Table 6.12).

A typical weight drop would have a peak force output of 860,000lbs (~430,000kg) at baseplate with an impulse frequency of 300Hz and a maximum cycle time of 10 seconds (Explorer 860 technical overview). Monk et al. (2004) indicates that although some compaction of the soil surface occurs, there is little or no long-term damage to the surface. Although the precise impact of using this technology on mammal fauna is unknown, disturbances would be of short duration and it is not expected that the ground seismic survey, using weight drop technology, will have any lasting negative impacts on mammals in the general area. Elephant are known to use infrasound communication with frequencies from 14-35 Hz for long distance communication with the best period for such communication just after sunset when night-time cooling enhances low-frequency sounds and thus maximises communication ranges (Garstang et al. 1995). Furthermore, elephant also use seismic communication i.e. ground borne stimuli which works better in sandy soils to avoid or threaten predators, assess and navigate within the environment, and communicate (O’Connell-Rodwell 2007 and O’Connell-Rodwell et al. 2007). Human noise in the 20-25 Hz frequency range can interfere with the transmission of seismic waves which could increasingly impede elephant seismic communication (Mortimer et al. 2018).

However, elephants are not sedentary in the proposed development area and mainly located to the east, in the Kaudum National Park with occasional movements to the west and south, between Kaudum and Mangetti National Parks and north-east between the Kaudum National Park and the Mahangu Core Area (Fig. 6.1 and Annex 2). The seismic surveys will be executed to the north and west of most elephant activities as well as be conducted during daytime hours i.e. expected to have limited impact on elephant communication. A typical surface weight drop using the Explorer 860 truck as source unit would have an impulse frequency of 300Hz and a maximum cycle time of 10 seconds per sampling site i.e. above the range elephants use for communication and be of short duration (Monk et al. 2004).

Habitat destruction, due to the creation and widening of new tracks, is more important although the actual footprint is small. However, no new tracks are envisaged and all seismic activity will be conducted along existing roads and tracks throughout the area. This would thus not lead to additional habitat disturbances and increased access into areas currently not as easily accessible which could lead to increased mortalities (e.g. vehicle mortalities and killing of perceived dangerous species such as wild dog, lion, etc.) and illegal collection of mammals as food (e.g. various ungulates) or trade (e.g. pangolin). The results of the likely negative impacts of the proposed 2D seismic survey on mammals and their associated habitats are summarised in Table 6.12.

<table>
<thead>
<tr>
<th>Status</th>
<th>Negative</th>
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</thead>
<tbody>
<tr>
<td>Probability</td>
<td>Improbable</td>
</tr>
<tr>
<td>Confidence</td>
<td>High</td>
</tr>
<tr>
<td>Extent</td>
<td>Site-specific</td>
</tr>
<tr>
<td>Duration</td>
<td>Very Short; for duration of the survey</td>
</tr>
<tr>
<td>Intensity</td>
<td>Mild</td>
</tr>
<tr>
<td>Significance</td>
<td>Medium to Low</td>
</tr>
</tbody>
</table>

Table 6.12: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on mammals.
6.3.2.6 Likely Impacts on Avian

The most important species are viewed as those classified as endangered (hooded vulture, white-backed vulture, tawny eagle, martial eagle, bateleur, southern ground-hornbill), vulnerable (secretarybird, white-headed vulture, lappet-faced vulture and) and near threatened (marabou stork, kori bustard) from Namibia (Simmons et al. 2015) as well as those classified by the IUCN (2020) as critically endangered (hooded vulture, white-headed vulture, white-backed vulture), endangered (lappet-faced vulture), vulnerable (secretarybird, tawny eagle, martial eagle, southern ground-hornbill) and near threatened (bateleur, kori bustard). An important species confirmed from the general area is the red-billed oxpecker. Although their numbers have increased in communal areas in north-eastern Namibia (Robertson and Jarvis 2000), elsewhere they have been negatively affected due to arsenic-based cattle dips. The general area has been heavily impacted in places, especially along the Omuramba Omatako and areas close to towns and settlements such as Rundu and Ncaute, etc., due to subsistence farming and logging activities and none of the unique birds are expected to be exclusively associated with the seismic survey routes. The proposed mitigations as detailed in the EMP Report are expected to minimise the overall effect on mammals potentially occurring in the area.

A typical weight drop would have a peak force output of 860,000lbs (~430,000kg) at baseplate with an impulse frequency of 300Hz and a maximum cycle time of 10 seconds (Explorer 860 technical overview). Monk et al. (2004) indicates that although some compaction of the soil surface occurs, there
is little or no long-term damage to the surface. Although the precise impact of using this technology on bird fauna is unknown, disturbances would be of short duration and it is not expected that the ground seismic survey, using weight drop technology, will have any lasting negative impacts on birds in the general area (Table 6.13).

Habitat destruction, due to the creation and widening of new tracks, especially through the Omuramba Omatako (and other ephemeral drainage lines), is more important although the actual footprint is small. However, no new tracks are envisaged and all seismic activity will be conducted along existing roads and tracks throughout the area. This would thus not lead to additional habitat disturbances and increased access into areas currently not as easily accessible which could lead to increased mortalities (e.g. vehicle mortalities) and illegal hunting of birds as food (e.g. various game birds) or trade (e.g. Meyer’s parrot). The results of the likely negative impacts of the proposed 2D seismic survey on avian and their associated habitats are summarised in Table 6.13.

Table 6.13: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on avian.

<table>
<thead>
<tr>
<th>Likely negative impacts of the proposed 2D seismic survey on avian and associated habitats</th>
<th>Status</th>
<th>Probability</th>
<th>Confidence</th>
<th>Extent</th>
<th>Duration</th>
<th>Intensity</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Negative</td>
<td>Improbable</td>
<td>High</td>
<td>Site-specific</td>
<td>Very Short; for duration of the survey</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

6.3.2.7 Likely Impacts on Tree and Shrub

The most important larger tree and shrub species expected to occur in the general area include all those formally protected (Annex 2) with the most important species viewed as *Baikiaea plurijuga*, *Burkea africana*, *Guibourti coleosperma*, *Dialium engleranum*, *Philenoptera violacea*, *Pterocarpus angolensis*, *Schinzophyton rautanenii*, *Sclerocarya birrea* and *Strychnos* species (Plates 5.12 - 5.17). Of these, the most important species, classified as Lower Risk/Near Threatened by the IUCN (2020), are viewed as *Pterocarpus angolensis* (African teak or Kiaat) (De Cauwer et al. 2014) and *Baikiaea plurijuga* (Zambezi/Rhodesian Teak) due to numbers having decreased due to overutilization for wood production; elephant damage and unseasonal human induced fires (Plates 6.1 - 6.3).

The most dominant tree and shrub species throughout the general area are *Burkea africana* (burkea) and *Terminalia sericea* (silver cluster leaf). The general area has been heavily impacted in places, especially along the Omuramba Omatako and areas close to towns and settlements such as Rundu and Ncaute, etc., due to subsistence farming and logging activities. The protected species occur widespread throughout the general area and not exclusively associated with the seismic survey routes. The proposed mitigations are expected to minimise the overall effect on larger trees and shrubs potentially occurring in the area.

The proposed 2D ground seismic survey will not affect the flora because of survey lines /profiles have been positioned along existing tracks or already cleared areas. Only minimum widening of the tracks may be necessary in some places in order to the survey trucks to pass easily.

The camp site will be situated on an area which is already cleared. No vegetation will be removed for the temporary campsite. The results of the likely negative impacts of the proposed 2D seismic survey on tree and shrub as key habitats are summarised in Table 6.14.
Plate 6.1: Logging of *Baikiaea plurijuga* (Zambezi/Rhodesian Teak † Near Threatened, IUCN 2020) is evident throughout the area (Cunningham, 2021).

Plate 6.2: Many areas close to the various tracks and roads and along the Omuramba Omatako are clear cut for subsistence farming (Cunningham, 2021).
Plate 6.3: Unseasonal fires, usually started to stimulate grass growth for cattle or accidental fires when clearing land for cultivation, are destructive throughout the area.

Table 6.14: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on tree and shrub species.

<table>
<thead>
<tr>
<th>Status</th>
<th>Negative</th>
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</thead>
<tbody>
<tr>
<td>Probability</td>
<td>Probable</td>
</tr>
<tr>
<td>Confidence</td>
<td>High</td>
</tr>
<tr>
<td>Extent</td>
<td>Site-specific</td>
</tr>
<tr>
<td>Duration</td>
<td>Medium-term</td>
</tr>
<tr>
<td>Intensity</td>
<td>Low</td>
</tr>
<tr>
<td>Significance</td>
<td>Low</td>
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</table>

6.3.2.8 Likely Impacts on Grass

The most dominant grass species throughout the general area are Aristida meridionalis (giant bristle-grass) and Eragrostis spp. especially E. pallens (broom grass) (Annex 2). The general area has been heavily impacted in places, especially along the Omuramba Omatako and areas close to towns and settlements such as Rundu and Ncaute, etc., due to subsistence farming and heavy grazing pressure. None of the important species are exclusively associated with the seismic survey routes. The proposed mitigations as detailed in the EMP Report are expected to minimise the overall effect on grass potentially occurring in the area.

Habitat destruction, due to the creation and widening of new tracks, especially through the Omuramba Omatako (and other ephemeral drainage lines), is more important although the actual footprint is small. However, no new tracks are envisaged and all seismic activity will be conducted along existing roads and tracks throughout the area. This would thus not lead to additional habitat disturbances and increased access into areas currently not as easily accessible which could lead to increased slash-and-burn practices for agricultural purposes; increased cattle numbers with added pressure on grasses. The results of the likely negative impacts of the proposed 2D seismic survey on grass key important habitats are summarised in Table 6.15.
Table 6.15: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on grass.

<table>
<thead>
<tr>
<th>Likely negative impacts of the proposed 2D seismic survey on the grass as key habitats and resources</th>
<th>Status</th>
<th>Probability</th>
<th>Confidence</th>
<th>Extent</th>
<th>Duration</th>
<th>Intensity</th>
<th>Significance</th>
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<tbody>
<tr>
<td></td>
<td>Negative</td>
<td>Probable</td>
<td>High</td>
<td>Site-specific</td>
<td>Medium-term</td>
<td>Low</td>
<td>Low</td>
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</table>

6.3.2.9 Likely Socioeconomic Impacts

The following is the summary of the socio-economic information for the Kavango West and East Regions, PEL 73, proposed seismic survey area and key areas of interest:

- There are 148466 people in Kavango East Region (3.8% of the total population of Namibia) and 89313 people in Kavango West (6.4% of the total population of Namibia).
- The growth rate of population is positive, yet at a slow paste, particularly for Kavango West - 0.6% which is the second lowest in the country. The growth rate for Kavango East is 1.6%.
- Female population lager than male population, Kavango East Region - 53.5% and Kavango West - 52.7%. At the constituency level female population differ - Kavango East constituencies have greater percentage of female population than Kavango West constituencies.
- The population of the area is youthful. Around 41.4% of people in Kavango East and 46.5% of people in Kavango West are youth from 0 to 14 years which is above national average for this age group (36.4%).
- People of working-age group (15-59 years) is smaller than the national average. Kavango East - 52.7% and Kavango West - 47.2% are people of working-age group.
- Kavango Regions have highest child mortality rates <5 (CMR) in the country - 112 deaths per 1000 live births (Namibia - 69 deaths per 1000 live birth).
- Kavango regions have the lowest life expectancy in Namibia - 43.9 years for male and 52.8 years for female.
- High proportion of persons with disabilities, particularly high in Kavango West (7.6%) which is the highest rate in Namibia. Kavango East has 6.0% of persons with disabilities.
- High percent of orphans aged 18 years and below, particularly in Kavango East - 15.9% with the national average of 12.5%.
- Kavango West region has the highest percentage of population without birth certificate (32.2%) followed by Kavango East with 19.9%. This limits people accessing social services, such as social grants and educational services.
- Population densities differ between Kavango East and Kavango West regions. Kavango East - 6.2 people per km² and Kavango West - 3.6 people per km².
- Long-term migration trend is negative. More people are migration out than migration in. Lack of employment leads to the high migration rate to other regions, particularly for men.
Within the area of interest there are three traditional (tribal) authorities - Shambyu, Gciruku and Mbukushu in the Kavango East, and Kwangali and Mbuza traditional authorities in the Kavango West Region.

Rukavango-speaking people constitute the largest language group - 79.4% of the population. San constitute around 0.4% of the regions' population.

The literacy rates for the Kavango East (82.3%) and Kavango West (82.9%) are below the national average. Male literacy rate slightly higher than female.

High unemployment rate, for Kavango East (48.2%) which is highest in the country.

Youth unemployment is particularly severe in Kavango East where more than half of youth (62.5%) are unemployed.

Kavango West Region has the highest percentage of informal employments (91.8%), Kavango East - 78.8%.

Farming is the main source of household income. Large share of people depends also on the old-age pensions, cash remittances, retirement fund, orphan, or disability grants.

Kavango regions have highest incidence of poverty, 53% of population. Poverty is defined as the number of households who are unable to afford sufficient resources to satisfy their basic needs. Within the region the highest poverty incidence is recorded in Kapako, Kahenge, Mashare, Mpungu constituencies.

Traditional dwellings are the most common type of housing, accounting for 72.9 % of all households in Kavango regions. Kavango East has a large percent distribution of improvised housing units/shacks - 46.7% of all households.

The Kavango West and East regions are relatively well covered with a network of roads; unfortunately, most of these roads are gravel or sandy roads that make travel difficult. Kavango East Region has one airport (Rundu) that accommodates national flights. Several smaller airstrips cater for the tourism sector especially in the eastern part of the region.

People living deeper in the interior areas are distant from social infrastructure, thus access to education and medical treatment is difficult.

Communities living in the northern part of the Kavango West and Kavango East regions along the road from Nkurenkuru to Rundu and Rundu to Divundu road are relatively well connected to the national electricity grid. The remainder of the rural communities situated away from the river and the main road are connected mostly with off-grid facilities.

Okavango River is the main source of water for the people living along the river, whereas villages away from river depend entirely on groundwater from boreholes supplied by MAWF and in some cases from seasonal pans. The urban areas - settlements and towns are provided with water by the NamWater.

The main economic activities are agriculture, mainly small-scale mahangu farming, providing some food self-sufficiency but little food security; aquaculture; timber harvesting; tourism, particularly in Kavango East Region.

There are several community forests within the Kavango East and Kavango West regions. Two community forests in Kavango West and ten community forests in Kavango East. Illegal harvesting of timber is on rise, mainly attributed to the high demand for timber worldwide and low incomes of local communities, and.

Tourism is mainly in Kavango East, but limited and undeveloped in Kavango West Region. Tourism is mostly focused on the eastern part of the region around Divundu, to some extent.
in the central part of the region next to the Kavango River and in Rundu. This is associated with the fact that most of the biodiversity, wildlife and scenic areas are found in the eastern part of the region. Kavango East Region falls within the Kavango Zambezi Transfrontier Conservation Area (KAZA TFCA).

One of the major possible impacts may be unrealistic job expectations about the proposed project. It is important for local communities to bear in mind that the proposed project activities will be for a short period of time and may require very high skilled workforce. The limited but temporary job opportunities will only be available for the debushing / widening of some of tracks as may be applicable. The limited number of people that will temporary be part of the survey team will not affect the social and cultural setting of the local communities because the strategy will be employ local from the villages along each specific survey line. The following is the summary of the likely negative socio-economic impacts that may be associated with the proposed seismic survey operations:

(i) In-flux of workers employed by contractors as well as a potential influx of job seekers, resulting in potential increase settlements.

(ii) The influx of opportunistic job seekers may result in increased numbers of opportunistic criminals taking advantage of high unemployment situation in country by creating job advertisement / opportunity frauds.

(iii) Disruption of family structures and social networks. Being away from the family and social networks potentially may lead to increased anti-social behaviour (e.g. alcohol and drug abuse), concurrent casual sexual contacts contributing to increased HIV-Aids rates.

(iv) Potential harmful interaction between workers employed form outside the area and the residents.

(v) Increased Covid-19 rates during the global Covid-19 pandemic if the health restrictions and protocols are not followed.

(vi) Increased crime rates often associated with alcohol and drug abuse. This could be the result of unsuccessful job seeker needing to find alternative source of income or could be the result of contract workers living in or near the villages.

(vii) Increased demand on water resources.

(viii) The presence of a larger number of workers living in the exploration camp on the site may pose a threat to the local farmers and also result in stock theft, poaching and damage to farm infrastructure, for example, fences.

(ix) Increased risk of veld fires on site and adjacent areas which may pose a threat to the livestock and crop farmers as well as damage or even destruction to farming infrastructure.

(x) Increased traffic, especially heavy vehicles, using public roads and safety concerns.

The results of the likely negative impacts of the proposed 2D seismic survey on socioeconomic environment are summarised in Table 6.16.

Table 6.16: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on the socioeconomic environment.

<table>
<thead>
<tr>
<th>Likely negative impacts of the proposed 2D seismic survey on the socioeconomic environment</th>
<th>Status</th>
<th>Probability</th>
<th>Confidence</th>
<th>Extent</th>
<th>Duration</th>
<th>Intensity</th>
<th>Significance</th>
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<tbody>
<tr>
<td></td>
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<td>Probable</td>
<td>High</td>
<td>Local</td>
<td>Very short</td>
<td>Low</td>
<td>Low</td>
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</table>
6.3.2.10 Likely Impacts on Existing Infrastructure, Current and Future Land uses

Localised compaction of the surface soils in sandy tracks may occur in some places creating a central ridge in the middle of the track which will make it difficult for lower raised vehicles to pass through the same tracks (Plate 6.4). Minor localised damage to the sandy and gravel roads may happen although this is highly unlikely because the survey equipment and support vehicle that will be used are no that heavy duty (Plate 6.5). Levelling of the raised central ridge of the tracks after conducting the proposed survey must be undertaken to make sure that existing local infrastructure continue to serve the local people and visitors to the survey area.

Local land uses around Area of Interest (AOI) and the proposed 2D seismic survey areas covering community forests, conservancies, agriculture, settlements, and villages (Fig. 6.1). The general area is not pristine anymore due to prolonged human impact (e.g. settlements, slash-and-burn farming practices, unseasonal fires, etc.), especially along the ephemeral Omuramba Omatako River, and more recently along the various tracks and roads throughout the area. However, there are some areas far from the rivers and tracks/roads which have less human impact (albeit not pristine), and viewed as more important. However, even these areas are likely to be affected by current and future human activities as increasingly new communal land allocations are expended over these areas.

Creating new tracks in pristine areas would result in the destruction of numerous protected tree species as well as result in access to these areas leading to further settlements as well as illegal harvesting and poaching and overall environmental destruction. However, no new tracks/roads are envisaged as the seismic surveying will be conducted on existing access routes and already disturbed areas throughout the proposed survey area coverage.

The proposed 2D seismic survey will be conducted along existing roads and tracks being used daily by local people and visitors within the survey area. Some of the proposed 2D seismic survey lines have been extended beyond the anticipated locations of key areas of interest and terminates closer to some important areas such as conservancies to the north-eastern parts of the survey. The reason for extending these lines beyond the expected basin boundaries is to make sure the entire basin, basin margins and potential sub-basins areas are covered in this once-off subsurface mapping exercise for completeness of the technical evaluations that will be undertaken after the 2D seismic survey data collection.

Although the survey lines are shown to be cutting across or passing close to community forestry and conservancies in Fig. 6.1, accesses already exists and no new roads or tracks will be created and proposed 2D seismic survey operations will coexist with current and future land uses. Table 6.16 summarises the results of the likely negative impacts of the proposed 2D seismic survey on current and future land uses. Results of the likely negative impact assessment of the proposed 2D seismic survey activities on the existing infrastructure, current and future land uses are summarised in Table 6.17.
Plate 6.4: Local sandy tracks which might have localised compaction in some places creating a central ridge in the middle of the track which will make it difficult for lower raised vehicles to pass through the same tracks.

Plate 6.5: Conditions of the already damaged existing tracks may be made worsened, although the proposed survey will be a once off operations and the likely impact will be limited.
Table 6.17: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on the existing infrastructure, current and future land uses.

<table>
<thead>
<tr>
<th>Influence of the proposed 2D seismic survey on the current and future land uses coexistence and potential land use conflicts</th>
<th>Status</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability</td>
<td>Probable; the use of supporting infrastructure areas such as access road for the proposed survey will coexist with the local uses and no land use conflicts are envisaged.</td>
<td></td>
</tr>
<tr>
<td>Confidence</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Extent</td>
<td>Local</td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>Long-term</td>
<td></td>
</tr>
<tr>
<td>Intensity</td>
<td>Mild</td>
<td></td>
</tr>
<tr>
<td>Significance</td>
<td>Medium to low</td>
<td></td>
</tr>
</tbody>
</table>

6.3.2.11 Likely Impacts on Ecosystem Functions, Services, Use Values and Non-Use Use

The proposed 2D seismic survey operations will be undertaken within the broader local, regional, and global ecosystem function (what the ecosystem does), services being provided by the ecosystem, direct use and benefits being derived from the ecosystem and within the overall existence values that is not linked to the direct use / benefits to current or future generations.

The proposed survey will be conducted along existence roads and tracks thereby minimising the overall likely negative impacts on the local ecosystem linked to regional and international ecosystems.

Table 6.18 summarises the assessment results of the likely negative environmental impacts that the proposed 2D seismic survey may have on the ecosystem functions, services, use values and non-use use.

Table 6.18: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on the ecosystem functions, services, use values and non-use or passive use.

<table>
<thead>
<tr>
<th>Likely negative environmental impacts assessment of the proposed 2D seismic survey activities on the ecosystem functions, services, use values and non-use or passive use</th>
<th>Status</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability</td>
<td>Improbable; Ecosystem functions, services, use values and non-use or passive use will not be affected in any way due to the localised nature of the proposed activities around the existing and disturbed roads and tracks.</td>
<td></td>
</tr>
<tr>
<td>Confidence</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Extent</td>
<td>Local (within 5 km of project area)</td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>Long-term</td>
<td></td>
</tr>
<tr>
<td>Intensity</td>
<td>Mild</td>
<td></td>
</tr>
<tr>
<td>Significance</td>
<td>Low</td>
<td></td>
</tr>
</tbody>
</table>

6.3.2.12 Physiography and Geology

The undulating forested Kalahari dune belt and the Omatako Ephemeral River channel and its tributaries are major distinctive landscapes features around the local topographic profiles of the survey area. The survey area is generally flat but undulating and the proposed survey lines are accessible through the existing roads and tracks. The risk of subsidence or landslides due to passage of survey vehicles is highly unlikely.

There are several different types of soils in the project area, each with its own peculiar geological, textural and weathering/erosion-driven properties, as well as anthropogenic footprints such as compaction by grazing animals, that are relevant to several issues that would need to be considered when executing the project.
These issues include: ecosystem services e.g. the role of soil in support of vegetation and higher food chain members; erosion and ponding potential, as well as surface runoff and their resultant geomorphological features; wind deflation, transportation and deposition of soil-derived particulates; organic matter content, surface sealing and capping and agricultural potential.

In the areas where the soils have high sand content, particularly along the sandy tracks, localised minor compaction by vehicles will occur (Plate 6.4). Soils along the Omatako Ephemeral Rivers and its tributaries are likely to be more susceptible to compaction and surface water ponding during the rainy season due to their higher clay contents (Plate 6.5).

However, if the soils are adequately dry (soil moisture content below the plastic limit) when activities occur and vehicles minimise the number of times they drive across those soils, compaction should be minimal. The following is the summary of the geology of the proposed project area:

(i) The Kalahari Basin formed during the uplift of the Great Escarpment and deposition occurred in grabens formed through recent tectonics.

(ii) The Kalahari Group Sediments is underlain by basement rocks of Karoo Basalts, Damara Quartzites and Dolomites and Pre-Damara Basement.

(iii) The Kalahari Basin is a vast inland basin which stretches over Angola, Namibia, Zambia, Botswana, and South Africa.

(iv) The Kalahari Sediments is a major primary aquifer of the Kavango Basin, with variable yield and water quality.

(v) The Karoo flood Basalts, dyke swarms and sills underlies much of the Kavango Basin, and.

(vi) A northwest fault is considered to be a major conduit of flood basalt and caused displacement of basalt to the south.

The likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on the physiography and geology are summarised in Table 6.19.

Table 6.19: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on the physiography and geology.

<table>
<thead>
<tr>
<th>Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on the physiography and geology</th>
<th>Status</th>
<th>Probability</th>
<th>Confidence</th>
<th>Extent</th>
<th>Duration</th>
<th>Intensity</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Negative</td>
<td>Improbable</td>
<td>High</td>
<td>Site-Specific</td>
<td>Very short</td>
<td>Mild</td>
<td>Low</td>
</tr>
</tbody>
</table>

6.3.2.13 Visual and Land Degradation along Tracks

It is anticipated that there will be some minor impacts on the aesthetics of the local environment especially around the camp site and along a specific road or track during the proposed 2D seismic survey operations. Dust generated by wind erosion or vehicles along the gravel roads is not expected to affect air visibility in the project area due to the limited low speed (30-60km / hr) vehicles can drive, once off drive through most of the roads and tracks except for the access roads / tracks connecting the camp site that may be used multiple times in a day.

Campsite layout and design should take into consideration the aesthetics of the selected area and vegetation screening must be always used to shield the campsite from local community or public roads and tracks. Use of modern line cutting technology, preferably mulchers for widening of the survey lines.
along minor tracks will ensure that minimal vegetation is removed, hence ensuring that re-vegetation will occur in a much shorter period since the rootstock, and seeds will be left along the tracks and this will promote faster re-growth. The likely negative environmental impacts assessment results of the proposed 2D seismic survey activities with respect to visual and land degradation are summarised in Table 6.20.

Table 6.20: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities with respect to visual and land degradation.

<table>
<thead>
<tr>
<th>Visual effects and land degradation of the campsite and survey vehicles along public roads / community areas and tracks resulting in land degradation</th>
<th>Status</th>
<th>Probability</th>
<th>Confidence</th>
<th>Extent</th>
<th>Duration</th>
<th>Intensity</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Negative</td>
<td>Improbable</td>
<td>High</td>
<td>Site-specific</td>
<td>Very short term</td>
<td>Mild</td>
<td>Low</td>
</tr>
</tbody>
</table>

6.3.2.14 Water Vulnerability Assessments and Water Supply Infrastructure

The following is summary of the groundwater characteristics of PEL 73 inclusive of the proposed 2D seismic survey area:

(i) Aquifers prevalent in the area are primary aquifers of saturated Kalahari Group sediments and secondary aquifers are fractured/weathered bedrock, fault zones cutting a cross basement geology, and Kalahari sediments and recent faults visible at surface. Overall groundwater potential is moderate to low.

(ii) Aquifers present along the rivers are saline artesian aquifers overlain by alluvium aquifers of paleo-channels of the Okavango River.

(iii) The main sources of groundwater are abstracted from hand dug wells and boreholes.

(iv) The depth to groundwater is deeper in the west than in the east.

(v) Groundwater flow is the manifestation of recent faulting found in the area, with a low-gentle gradient.

(vi) Most boreholes have yields between 2-4m$^3$/h, with yields of 8m$^3$/h on average.

(vii) Most boreholes have water of a good quality with TDS levels of 500-1000mg/l.

(viii) Boreholes with poor quality water are high in sodium salts and are associated with stagnant waters.

(ix) Groundwater quality is maintained with each recharge episode.

(x) Average borehole depth is slightly above 90m, with average water strikes at 51m and saturated thickness at 43m.

(xi) Borehole yields are sufficient to fulfil the water requirements of the exploration phase, and.

(xii) A Groundwater Monitoring and Management Plan are tools of effective groundwater management and is for the:

The proposed 2D ground seismic survey will not influence the quality of the local groundwater resources provided that no wastewater is discharged directly into the ground from either along the survey lines or around the camp site areas. The overall water vulnerability to pollution because of the proposed
activities as well as other existing activities is moderate. The Kalahari Sands which are the regional groundwater aquifer is very deep (100 m) but very porous and discharge of wastewater or chemicals/oils into the ground without any form of engineered barrier, may eventually, result in localised groundwater pollution. Discharge of liquid or solid wastes including waste water, chemical, fuels or oils into any public stream is prohibited and the proponent must implement the provisions of the EMP on water and waste management.

Liquid effluent discharges and oil or chemical leaks at the campsite, if not properly managed, can potentially lead to pollution of an underlying shallow groundwater source. The source of energy for the proposed 2D seismic survey will be free weight drop from the Explorer with wireless geophones. Explosives which are known to be associated with water pollution because of the remaining residues from the survey operations will not be used for this survey.

The survey will use existing roads and tracks and it is highly unlikely that the proposed survey will result in damage to the local water wells or water infrastructures. If there are issues with existing boreholes designs, then that should have happened when these roads were constructed using very heavy compacting road construction equipment. Additionally, the roads are today being used by all types of vehicles and tracks and all inducing vibration to the surrounding areas. Seismic survey activities have been successfully conducted in Maltahöhe in 2007 and Kavango West Region in 2017 and both surveys never reported environmental issues resulted to the collapse of community water wells. The results of the likely negative impacts of the proposed 2D seismic survey on water vulnerability assessments and water supply infrastructure are summarised in Tables 6.21 - 6.23.

Table 6.21: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on the surface and groundwater quality.

<table>
<thead>
<tr>
<th>Likely negative physical impacts on the surface and groundwater quality along the proposed survey lines (existing roads and tracks) because of the proposed 2D seismic survey operations</th>
<th>Status</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability</td>
<td>Improbable</td>
<td></td>
</tr>
<tr>
<td>Confidence</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Extent</td>
<td>Site-Specific</td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>Very short</td>
<td></td>
</tr>
<tr>
<td>Intensity</td>
<td>Mild</td>
<td></td>
</tr>
<tr>
<td>Significance</td>
<td>Low</td>
<td></td>
</tr>
</tbody>
</table>

Table 6.22: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on increased water consumption / depletion of water resources.

<table>
<thead>
<tr>
<th>Depletion of water resources due to increased water consumption / during the proposed 2D seismic survey activities</th>
<th>Status</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability</td>
<td>Definite</td>
<td></td>
</tr>
<tr>
<td>Confidence</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Extent</td>
<td>Site specific</td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>Very short</td>
<td></td>
</tr>
<tr>
<td>Intensity</td>
<td>Mild</td>
<td></td>
</tr>
<tr>
<td>Significance</td>
<td>Low</td>
<td></td>
</tr>
</tbody>
</table>

Table 6.23: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on the existing local community water supply infrastructure along the proposed survey lines (existing roads and tracks).

<table>
<thead>
<tr>
<th>Likely negative physical impacts (damage) on the existing local community water supply infrastructure along the proposed survey lines (existing roads and tracks).</th>
<th>Status</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability</td>
<td>Negligible</td>
<td></td>
</tr>
<tr>
<td>Confidence</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Extent</td>
<td>Site specific</td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>Very short term</td>
<td></td>
</tr>
<tr>
<td>Intensity</td>
<td>Mild</td>
<td></td>
</tr>
<tr>
<td>Significance</td>
<td>Low</td>
<td></td>
</tr>
</tbody>
</table>
6.3.2.15 Security, Public Safety, Occupational Health and Safety

Security, public safety, occupational health, and safety security is a major concern are all very important component to any project operations with respect to the local community and workers. During the project course, security issues may escalate due to free movement of people. The increase in human activity, including vehicle and seismic exploration activity, could increase the potential for human-related conflicts, including ignition of wildfires and loss of property or equipment.

During the seismic survey, the workers, visitors, and the local community may be exposed to occupational and health hazards not normally encountered during day to day life or activity in the area. Accidents between vehicles or vehicles and humans or wildlife may occur. Workers or local people may be exposed to other risks such as falls, fires, and attacks from criminal elements.

The Proponent as well as the seismic survey contractor and subcontractors will be required to have security detail, public safety and Occupational Health and Safety (OHS) procedures and manuals specifically for the proposed 2D seismic survey operations. Table 6.24 summarises the likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on the community and workers security, public safety, Occupational Health, and Safety

Table 6.24: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on the community and workers security, public safety, Occupational Health, and Safety.

<table>
<thead>
<tr>
<th>Status</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability</td>
<td>Improbable; Addition to the already existing structures and disturbed land</td>
</tr>
<tr>
<td>Confidence</td>
<td>High</td>
</tr>
<tr>
<td>Extent</td>
<td>Local (within 5 km of project area)</td>
</tr>
<tr>
<td>Duration</td>
<td>Long-term</td>
</tr>
<tr>
<td>Intensity</td>
<td>Mild</td>
</tr>
<tr>
<td>Significance</td>
<td>Low</td>
</tr>
</tbody>
</table>

6.3.2.16 Noise and Vibration

The use of survey equipment and all the supporting vehicles at the campsite and along the proposed survey lines will likely be associated with the noise generation and vibrations that may affect the survey crew, neighbouring communities and their livestock, and wildlife. The base camp site can also be a source of noise pollution especially if generators are used for electricity generation. The maximum tolerable noise level for workers without hear protection over an 8 hours period is 90 dBA. A 3-dBA increase (up to 120 dBA) is allowed for every halving of daily exposure so the maximum tolerable noise level for 2 hours of exposure is 96 dBA (i.e., plus 6 dBA). If operator noise levels experienced may exceed 90 dBA, it is likely that the noise levels may present a problem for the workers without hear protection equipment.

Some noise sensitive areas (e.g. Conservancies, national park, birds nesting sites along the survey lines, schools, clinics and villages) are found in the project area. However, no significant impact is anticipated due to the localised and temporal nature of this project and its expected low noise and vibrations levels to be generated. The length of time the seismic crew will spend in any one location is short, with up to 10 km per day of acquisition possible in good weather conditions. This will reduce the overall noise impacts on localised residential receptors to less than one day of actual disturbance.

When it comes to vibrations, it is important to note that 2D seismic survey is not same as earthquake produced seismic waves. Earthquake generate seismic waves which have periods and resolution of minutes and kilometres, respectively, while the 2D seismic survey operations produces waves with periods and resolution of tenths of a second and tens of meters, respectively. The seismic survey waves will not be capable of destroying homes even if the houses are built out of mud. The proposed 2D seismic survey operations will also not going affect the local water quality or cause damage to the
subsurface structures of the local water supply wells and aboveground infrastructure such as tanks or reservoirs.

Ground motion caused by an onshore seismic survey vibration is generally barely perceivable (Teasdale et al., 2006). The further away one is from a source, the less likelihood one would feel the vibration. Many homes have loose objects and their movement is highly sensitive to vibration and useful first indicators of motion intensity. Earlier studies by Nicholls et al., (1971) and Siskind et al., (1980) have shown that many household activities that generate vibrations that are well above the perceptible range, but owing to their known sources, the owners show little or no concern. According to Teasdale et al., (2006) one of the most important aspects of any vibration excitation is the response of the local population in the area. Humans can perceive very low levels of sound and vibration which can also lead to generation of copious amount of dust and may wonder if the perceived events have some damage potential to the health and homes.

Following an earlier study by Teasdale et al., (2006) on vibration tests, responses were measured for some common household practices such as hammering of nail into wall, door slamming and the use of fireplace. Also monitored were the daily and seasonal responses of existing cracks to normal environmental stresses. The study showed that common household activities generate significant strains compared to those induce vibration from external sources. However, this varies according to the nature of the activities, distance from the source within the house, and the house construction, for example a slab-on-grade compared to a structure wood floor. These studies have shown that common household activities such as hammering a nail into a wall would cause more vibration to a house than a typical seismic truck operating in the area.

Overall, localised and limited noise and vibrations may be associated with the survey trucks and support vehicles conducting the surveys along the profile. However, considering the temporary nature of the proposed activities and the sparsely population of the local area with limited fauna, the likely effects of the noise and vibrations that may be associated with the proposed 2D ground seismic survey operations will be low, highly localised and over a short period (Table 6.25).

Table 6.25: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities with respect to noise and vibrations.

<table>
<thead>
<tr>
<th>The survey equipment and all the supporting vehicles at the campsite and along the proposed survey lines will likely be associated with the noise generation and vibrations that may affect the survey crew, neighbouring communities and their livestock, and wildlife</th>
<th>Status</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability</td>
<td>Improbable</td>
<td></td>
</tr>
<tr>
<td>Confidence</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>Extent</td>
<td>Site-specific</td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>Very Short</td>
<td></td>
</tr>
<tr>
<td>Intensity</td>
<td>Negligible</td>
<td></td>
</tr>
<tr>
<td>Significance</td>
<td>Low</td>
<td></td>
</tr>
</tbody>
</table>

6.3.2.17 Dust and Air Quality

The proposed 2D seismic survey operations is likely to be undertaken during the dry season between April to October when local winds can raise substantial quantities of dust. Air quality variation relates primarily to changes in the wind-speeds in the area, and the associated particulate dust that it transports from one place to another.

The disturbance of fine grained (fine silt to clay sized particles) soils by vehicles traversing the area may lead to limited wind erosion in the area, leading to airborne dust during windy conditions. However, the scale of these transient fugitive dusts is insignificant (more so in relation to dusts raised by the strong winds in the area), and would not alter the ambient air quality. On a micro-scale, air quality may also be affected by exhaust emissions from vehicles and machinery, but this is also of a transient and insignificant nature. Sources of offensive but localised odours would include exhaust emissions from vehicles and other equipment, as well as poorly managed waste storage / transfer and sanitary facilities at the campsite. Likely localised air quality impacts may be associated with limited and few traffic movements and the likely negative effects will be negligible (Table 6.26).
Table 6.26: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on dust and air quality.

<table>
<thead>
<tr>
<th>Proposed 2D seismic survey operations likely dust generation and influences on the air quality.</th>
<th>Status</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Probability</td>
<td>Improbable</td>
</tr>
<tr>
<td></td>
<td>Confidence</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Extent</td>
<td>Site-specific</td>
</tr>
<tr>
<td></td>
<td>Duration</td>
<td>Very Short</td>
</tr>
<tr>
<td></td>
<td>Intensity</td>
<td>Negligible</td>
</tr>
<tr>
<td></td>
<td>Significance</td>
<td>Low</td>
</tr>
</tbody>
</table>

6.3.2.18 Solid and Liquid Waste Management:

Although the proposed 2D seismic survey operations will be conducted over a very short period, various types of wastes (liquids and solids) are likely to be generated mainly around the proposed campsite and along the survey lines/profiles. The campsite will be equipped to handle both the liquid and solid waste likely to be generated.

The campsite will be equipped with chemical toilets or French drain for the management of waste water with mobile chemical toilets made available along the profiles/survey lines. Waste bags for management of solid waste will be made available at the campsite and will also be carried along the survey lines and no litter will be tolerated.

Burial of solid waste around the campsite, along the survey lines or anywhere within or outside the PEL area is prohibited. All solid waste collected at the campsite and along the survey lines/profiles will only be disposed at an approved municipal facility at Rundu. Continuous debriefing and awareness of the survey team on all matters related to environmental management must be undertaken.

The types of waste that will be generated at the camp sites and/or work sites during the survey operation can be grouped into two categories, non-hazardous and hazardous. The non-hazardous wastes would include: Domestic wastes and effluents, plastics, metal cans, and paper. The hazardous wastes would include: Medical and pharmaceutical wastes, waste oils, and used batteries.

The summary of the likely negative environmental impacts assessment results of the proposed 2D seismic survey with respect to waste (solid and liquid) management is shown in Table 6.27.

Table 6.27: Likely negative environmental impacts assessment results of the proposed 2D seismic survey with respect to waste (solid and liquid) management.

<table>
<thead>
<tr>
<th>Influence of the solid and liquid waste management practices around the campsite and survey lines with respect to the proposed 2D seismic survey operations</th>
<th>Status</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Probability</td>
<td>Improbable; Limited volumes with waste management procedures in place and sources sorting infrastructures for effective onsite solid waste management will be provided</td>
</tr>
<tr>
<td></td>
<td>Confidence</td>
<td>Medium</td>
</tr>
<tr>
<td></td>
<td>Extent</td>
<td>Local (&lt;5 km)</td>
</tr>
<tr>
<td></td>
<td>Duration</td>
<td>Very short term</td>
</tr>
<tr>
<td></td>
<td>Intensity</td>
<td>Negligible</td>
</tr>
<tr>
<td></td>
<td>Significance</td>
<td>Low</td>
</tr>
</tbody>
</table>

6.3.2.19 Likely Impacts of an Accidental Event

Different types of accidental events may occur during the proposed 2D seismic survey operations. Such accidental events may include: Personal injury, fire, collisions between vehicles, collisions between vehicles and humans or animals, fuel/oil pollution on land from storage, tanks or pipe leaks or rupture or accident during transportation by trucks. To effectively manage all the accidental events that might
occur, the Proponent through the appointed 2D seismic survey Contractor shall prepare an Emergency Response Plan (ERP) linked to specific operational procedures in line with both the national regulations and best practices in the oil and gas industry. Table 6.28 summarises the likely negative environmental impacts assessment results of the proposed 2D seismic survey with respect accidental events.

Table 6.28: Likely negative environmental impacts assessment results of the proposed 2D seismic survey with respect accidental events.

<table>
<thead>
<tr>
<th>Occurrence of an accidental event such as personal injury, fire, collisions between vehicles, collisions between vehicles and humans or animals, fuel / oil pollution on land from storage, tanks or pipe leaks or rupture or accident during transportation by trucks during the proposed 2D seismic survey operations</th>
<th>Status</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability</td>
<td>Improbable; An Emergence Response Plan (ERP) and equipment such as onsite firefight equipment will be put in place as part of the project implementation</td>
<td></td>
</tr>
<tr>
<td>Confidence</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>Extent</td>
<td>Site-specific</td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>Very Short</td>
<td></td>
</tr>
<tr>
<td>Intensity</td>
<td>Mild</td>
<td></td>
</tr>
<tr>
<td>Significance</td>
<td>Low</td>
<td></td>
</tr>
</tbody>
</table>

6.3.2.20 Likely Impacts on Archaeological, Paleontological, and Historical Aspects

The proposed 2D seismic survey lines to be undertaken along the existing roads and tracks will not likely affect local archaeological resources although existing disturbance of the areas through previous land-use system and existing infrastructure development activities would or might have probably already compromised some of the sites if existed. Due to their established significance, the identified archaeological sites within the survey area must still be treated as "no go zones" and no disturbances should occur given their vulnerability nature and sensitivities. The "chance finds" procedure which covers the actions to be taken by the Proponent if a heritage site or item has been discovered, must be always implemented. This will involve the reporting to the National Heritage Council (NHC) the discovery of any suspected archaeological resources so that investigation and assessment by a trained archaeologist or other appropriately qualified person can be conducted. The "chance finds" procedure is intended to ensure compliance with the relevant provisions of the National Heritage Act, 2004, (Act No. 27 of 2004), especially Section 55 (4): "a person who discovers any archaeological object must as soon as practicable report the discovery to the Council." Table 6.29 summarises the likely negative environmental impacts assessment results of the proposed 2D seismic survey on the archaeological, paleontological, and historical resources.

Table 6.29: Likely negative environmental impacts assessment results of the proposed 2D seismic survey on the archaeological, paleontological, and historical resources.

<table>
<thead>
<tr>
<th>Disturbance / damage of sites of archaeological, historical and/or cultural value during the proposed 2D seismic survey operations</th>
<th>Status</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability</td>
<td>Improbably (the Proposed 2D seismic survey will be conducted along existing roads and tracks with greater line offset potential due to the use of wireless receivers).</td>
<td></td>
</tr>
<tr>
<td>Confidence</td>
<td>Low</td>
<td></td>
</tr>
<tr>
<td>Extent</td>
<td>Site Specific</td>
<td></td>
</tr>
<tr>
<td>Duration</td>
<td>Permanent</td>
<td></td>
</tr>
<tr>
<td>Intensity</td>
<td>Very Severe; if archaeological artefacts, cultural or historical sites are destroyed</td>
<td></td>
</tr>
<tr>
<td>Significance</td>
<td>Low</td>
<td></td>
</tr>
</tbody>
</table>

6.3.2.21 Likely Negative Impacts on Climate Change

According to the 2020 fourth National Communication to the United Nations Framework Convention on Climate Change published by the Ministry of Environment, Forestry and Tourism, Namibia's already low climate resilience and adaptive capacities continue to be threatened by changes in temperature and precipitation, periodic droughts, and floods. Namibia's future vulnerability to climate change will be
determined by the nature of the biophysical changes to which its population, economy and livelihoods are exposed, and by national and individual capacities to manage, recover from, and adapt to these changes (Republic of Namibia, 2020).

The Paris Agreement has a goal of limiting global warming to below 2°C (and ideally below 1.5°C) above pre-industrial levels. Although Namibia is one of the highly vulnerable nations, such that even a 1.5°C increase in global temperature will have severe local impacts, negatively affecting the agriculture, water, health, and biodiversity sectors (Republic of Namibia, 2020). Through the National Policy on Climate Change, introduced in 2011, Namibia is working towards reducing the effects of global warming on communities and sectors through short and long-term resilience and adaption strategies. However, the current green environmental financing models that are dependent on donations, loans, and grants from developed countries coupled with massive socioeconomic challenges and rural generational poverty, will see Namibia struggle to achieve its NetZero by 2050. As such Namibia cannot afford to abruptly stop all greenhouse emitting industries such as oil and gas exploration and switch to green energy overnight. Even the developed and industrialised countries responsible for all the historical, current and the next thirty (30) years of greenhouse gases emissions have adopted long-term strategies of transforming to greener economies and hope to achieve NetZero by 2050.

Namibia is a developing country struggling economically with high levels of debt, high unemployment, high poverty levels, challenging social economic issues, riddled with unequal distribution of wealth and majority of the indigenous Namibians swimming in inherited generational poverty. The adoption of coexistence developmental approaches in the diversification of the national resources base will greatly help the country to widen it income base and financial independence to be able to fund both the short- and long-term climate change resilience and adaption strategies for the benefit of all Namibians.

The proposed 2D seismic survey can be classified as a small, short-term, local project aimed at supporting the development of fossil fuel opportunities in northern Namibia while at the same time will provide datasets that could support the development of other sectors such as search for groundwater, geothermal energy, and minerals resources. The proposed 2D seismic survey inclusive of all the supporting activities such as the campsite operations are likely to be associated with the releases of localised and site-specific emissions that may have some localised influence on the local climate with low global significant. The survey equipment, vehicles and generators will emit greenhouse gases and various air contaminants, including sulphur oxides, nitrogen oxides, carbon monoxide and particulate matter. Within the proposed 2D seismic survey area climate change threats have direct impact on agriculture and food security, water availability and health and the ferocity of the forest fires so common in both Kavango West and East Regions.

The releases of airborne particulate matter can result from various activities including driving along the gravel or sandy tracks as well as naturally windblown matter. It is important that all the equipment to be used for the proposed survey will be serviced and maintained regularly. The proposed survey shall be overseen by experienced personnel and the operation must adhere to the provisions of the national international best practices, regulations of International Association of Geophysical Contractors (IAGC) and the applicable national legislation and regulations. The short-term duration of the proposed 2D seismic survey activities will result in negligible cumulative impacts for most environmental and social factors, and no long-term cumulative impacts following cessation of the proposed activities. Table 6.30 summarises the likely negative environmental impacts assessment results of the proposed 2D seismic survey with respect to the contributions to global Climate Change.

Table 6.30: Likely negative environmental impacts assessment results of the proposed 2D seismic survey with respect to the contributions to global Climate Change.

<table>
<thead>
<tr>
<th>Contributions to climate change due to increased vehicles movements / equipment emissions during the proposed 2D seismic survey operations</th>
<th>Status</th>
<th>Probability</th>
<th>Duration</th>
<th>Intensity</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Negative</td>
<td>Improbable: Unlikely due to very limited scale of the proposed operations and remoteness of the surrounding</td>
<td>Very short-term</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>High</td>
<td>Site-specific</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2D Seismic Survey Operations - 221 - Vol. 2 of 3 EIA Report for PEL 73-March 2021
6.3.2.22 Likely Negative Cumulative Impacts

Cumulative impacts are those impacts which result from the incremental impact of the proposed activities (2D seismic survey operations) when added to other past, present, and reasonably near future activities such as agriculture, conservation, forestry, new settlements due to population growth and new land allocation. The cumulative impacts on the habitats, fauna, and flora species, ecosystem functions, services, use values and non-use use, physiography and geological resources, water, and water supply infrastructure vulnerability within the proposed survey area are considered insignificant. The proposed survey will be conducted along existing roads and tracks.

All other operational related impacts such as increased pressures on existing infrastructures, current and future land uses and services, visual, noise, dust, vibration, waste management, security, Public Safety, Occupational Health and Safety and accidental events will be short-term and site-specific and with less additional influence by the other past, present, and reasonably near future activities. The scale of fugitive particulate material generation and their impacts on the surrounding environment is generally negligible, particularly because the naturally strong winds have a much greater impact in this regard. Adequate mitigation measures are, however, available during the operations phase to limit the generation of dust in the localised area and where the activity creates greater than normal levels of traffic.

The scope for cumulative impacts on archaeological and cultural sites from the proposed activity are low, because the survey will be conducted along existing roads and tracks using wireless receiver with a wider line offset potential. If archaeological and cultural sites are identified, they can easily be avoided by offsetting the line and flagged so as not to be disturbed. Table 6.31 summarises the likely negative environmental impacts assessment results of the proposed 2D seismic survey with respect to the negative cumulative impacts.

Table 6.31: Likely negative environmental impacts assessment results of the proposed 2D seismic survey with respect to cumulative impacts.

<table>
<thead>
<tr>
<th>Proposed 2D seismic survey cumulative impacts on the habitats, fauna, and flora species, ecosystem functions, services, use values and non-use use, physiography and geological resources, water, and water supply infrastructure vulnerability and other components of the receiving environment</th>
<th>Status</th>
<th>Probability</th>
<th>Confidence</th>
<th>Extent</th>
<th>Duration</th>
<th>Intensity</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Negative</td>
<td>Improbable</td>
<td>Medium to High</td>
<td>Site-specific</td>
<td>Very short</td>
<td>Low</td>
<td>Low</td>
</tr>
</tbody>
</table>

5.5.3 Impact Assessment Process

5.5.3.1 Overall Impact Individual Components Assessment Results

The overall impact assessment of the individual components of the receiving environment covered the magnitude, duration, extent, and probability of the potential impacts due to the proposed 2D seismic survey activities interacting with the various components of the receiving environment as presented in form of a matrix table shown in Table 6.32. The overall assessment is based on the grading of the impact assessment results of the individual positive and negative components of the receiving environment shown in Tables 6.3-6.8 and 6.9-6.31, respectively.

The overall severity of potential environmental impacts of the proposed 2D seismic survey activities on the receiving environment will be of low magnitude, temporally duration, localised extent, and low probability of occurrence due to the limited scope of the proposed activities and the use of step progression approach in advancing exploration. The standard resources step by step approach to exploration represented by the proposed 2D seismic survey operations will allow the Proponent to continuously review and update the various component of the receiving environment as may be
applicable against the results of exploration success. The implementation of the subsequent stage/s of exploration will be subject to the positive outcomes of previous activities as graded.

5.5.3.2 Assessment Results of the Overall Significant Impacts

The assessment results of the overall significant impacts depended upon the degree to which the proposed 2D seismic survey activities are likely to result in unwanted consequences on the receptor. Overall, the assessment of significant impacts has focused on the ecosystem-based approach that considers potential impacts to the ecosystem. The main key sources of impacts that have been used in the determination of significant impacts are all the activities associated with the proposed 2D seismic survey operations. Each of the main areas of impact have been identified and assessed as follows:

- Positive impacts are classified under a single category; they are then evaluated qualitatively with a view to their enhancement, if practical.
- Negligible or low impacts will require little or no additional management or mitigation measures (on the basis that the magnitude of the impact is sufficiently small, or that the receptor is of low sensitivity), and.
- Medium or high impacts require the adoption of management or mitigation measures to limit or reduce the impact to an acceptable level.

Overall, the results of the significant impact assessment for the proposed 2D seismic survey are shown in Tables 6.33. It is important to note that the assessment of the likely impacts as shown in Tables 6.3-6.32, have been considered without the implementation of mitigation measures detailed in the EMP Report.

The need for implementation of the appropriate mitigation measures as presented in the EMP Report have been determined on the results of the impact assessment (Tables 6.3-6.32) and the significant impacts as detailed in Table 6.33.
Table 6.32: Summary results of the overall likely impacts of the proposed 2D seismic survey activities on the individual components of the receiving environment with respect to duration, geographical extent, and probability occurrence.

<table>
<thead>
<tr>
<th>RECEIVING ENVIRONMENT SENSITIVITY</th>
<th>PHYSICAL ENVIRONMENT</th>
<th>BIOLOGICAL ENVIRONMENT</th>
<th>SOCIOECONOMIC, CULTURAL, AND ARCHAEOLOGICAL ENVIRONMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SENSITIVITY RATING</strong></td>
<td><strong>CRITERIA</strong></td>
<td>Water Quality</td>
<td>Physical Infrastructure and Resources</td>
</tr>
<tr>
<td>1</td>
<td>Negligible</td>
<td>The receptor or resource is resistant to change or is of little environmental value</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Low</td>
<td>The receptor or resource is tolerant of change without detriment to its character, is of low environmental or social value, or is of local importance.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Medium</td>
<td>The receptor or resource has low capacity to absorb change without functionally altering its present character, is of high environmental or social value, or is of national importance.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>High</td>
<td>The receptor or resource has moderate capacity to absorb change without significantly altering its present character, has some environmental or social value, or is of district/regional importance.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Very High</td>
<td>The receptor or resource has little or no capacity to absorb change without fundamentally altering its present character, is of very high environmental or social value, or is of international importance.</td>
<td></td>
</tr>
</tbody>
</table>

**SOURCES OF POTENTIAL IMPACT**

1. Planning and mobilisation (Pre-survey preparation)
   - Water Quality: 2
   - Physical Infrastructure and Resources: 2
   - Air Quality, Noise and Dust: 2
   - Landscape Topography: 2
   - Soil Quality: 2
   - Climate Change Influences: 1
   - Habitat: 2
   - Protected Areas: 1
   - Flora: 2
   - Fauna: 2
   - Ecosystem functions, services, use values and non-use or passive use: 2
   - Local, regional, and national socioeconomic settings: 2
   - Subsistence Agriculture: 2
   - Community Forestry: 2
   - Tourism and Recreation: 2
   - Cultural, Biological and Archaeological Resources: 1

2. Camp sites setups and widening of tracks and creation of limited new access as may be applicable
   - Water Quality: 2
   - Physical Infrastructure and Resources: 2
   - Air Quality, Noise and Dust: 2
   - Landscape Topography: 2
   - Soil Quality: 2
   - Climate Change Influences: 1
   - Habitat: 2
   - Protected Areas: 1
   - Flora: 2
   - Fauna: 2
   - Ecosystem functions, services, use values and non-use or passive use: 2
   - Local, regional, and national socioeconomic settings: 2
   - Subsistence Agriculture: 2
   - Community Forestry: 2
   - Tourism and Recreation: 2
   - Cultural, Biological and Archaeological Resources: 1

3. Actual data acquisition along the individual profiles / survey lines
   - Water Quality: 2
   - Physical Infrastructure and Resources: 2
   - Air Quality, Noise and Dust: 2
   - Landscape Topography: 2
   - Soil Quality: 2
   - Climate Change Influences: 1
   - Habitat: 2
   - Protected Areas: 1
   - Flora: 2
   - Fauna: 2
   - Ecosystem functions, services, use values and non-use or passive use: 2
   - Local, regional, and national socioeconomic settings: 2
   - Subsistence Agriculture: 2
   - Community Forestry: 2
   - Tourism and Recreation: 2
   - Cultural, Biological and Archaeological Resources: 1

4. Demobilisation and Closure (Survey Completion)
   - Water Quality: 2
   - Physical Infrastructure and Resources: 2
   - Air Quality, Noise and Dust: 2
   - Landscape Topography: 2
   - Soil Quality: 2
   - Climate Change Influences: 1
   - Habitat: 2
   - Protected Areas: 1
   - Flora: 2
   - Fauna: 2
   - Ecosystem functions, services, use values and non-use or passive use: 2
   - Local, regional, and national socioeconomic settings: 2
   - Subsistence Agriculture: 2
   - Community Forestry: 2
   - Tourism and Recreation: 2
   - Cultural, Biological and Archaeological Resources: 1

5. Any accidental event that may be associated with the routine and physical presence operational activities
   - Water Quality: 2
   - Physical Infrastructure and Resources: 2
   - Air Quality, Noise and Dust: 2
   - Landscape Topography: 2
   - Soil Quality: 2
   - Climate Change Influences: 1
   - Habitat: 2
   - Protected Areas: 1
   - Flora: 2
   - Fauna: 2
   - Ecosystem functions, services, use values and non-use or passive use: 2
   - Local, regional, and national socioeconomic settings: 2
   - Subsistence Agriculture: 2
   - Community Forestry: 2
   - Tourism and Recreation: 2
   - Cultural, Biological and Archaeological Resources: 1
Table 6.33: Summary results of the overall likely significant impacts that the proposed 2D seismic survey activities will have on the components of the receiving environment with respect to duration, geographical extent, and probability occurrence.

<table>
<thead>
<tr>
<th>IMPACT SEVERITY</th>
<th>RECEPTOR CHARACTERISTICS (SENSITIVITY)</th>
<th>PHYSICAL ENVIRONMENT</th>
<th>BIOLOGICAL ENVIRONMENT</th>
<th>SOCIOECONOMIC, CULTURAL, AND ARCHAEOLOGICAL ENVIRONMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Magnitude, Duration, Extent, Probability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Very High (5)</td>
<td>Major [5/5]</td>
<td>2/2</td>
<td>2/2</td>
<td>2/2</td>
</tr>
<tr>
<td></td>
<td>High [4]</td>
<td>2/2</td>
<td>2/2</td>
<td>2/2</td>
</tr>
<tr>
<td></td>
<td>Medium [3]</td>
<td>2/2</td>
<td>2/2</td>
<td>2/2</td>
</tr>
<tr>
<td></td>
<td>Low (2)</td>
<td>2/2</td>
<td>2/2</td>
<td>2/2</td>
</tr>
<tr>
<td>Negligible (1)</td>
<td>Minor [1/1]</td>
<td>2/2</td>
<td>2/2</td>
<td>2/2</td>
</tr>
</tbody>
</table>

SOURCES OF POTENTIAL IMPACT ROUTINE AND PHYSICAL PRESENCE OPERATIONAL ACTIVITIES

1. Planning and mobilisation (Pre-survey preparation) 2/2 2/2 2/2 2/2 1/2 2/2 1/2 2/2 2/2 2/2 2/2 1/2 1/2
2. Camp sites setups and widening of tracks and creation of limited new access as may be applicable 2/2 2/2 2/2 2/2 1/2 2/2 1/2 2/2 2/2 2/2 2/2 2/2 2/2 1/2 1/2
3. Actual data acquisition along the individual profiles / survey lines 2/2 2/2 2/2 2/2 1/2 2/2 1/2 2/2 2/2 2/2 2/2 2/2 2/2 1/2 1/2
4. Demobilisation and Closure (Survey Completion) 2/2 2/2 2/2 2/2 1/2 2/2 1/2 2/2 2/2 2/2 2/2 2/2 2/2 1/2 1/2

UNPLANNED ACCIDENTAL EVENTS

5. Any accidental event that may be associated with the routine and physical presence operational activities 2/2 2/2 2/2 2/2 1/2 2/2 1/2 2/2 2/2 2/2 2/2 2/2 2/2 1/2 1/2
7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

The key AOI interests (Potential Sedimentary Basin Area) targeted by the Proponent does not fall in a highly sensitive area such as a national park or groundwater protection zone or highly active catchment area. The overall project area falls within KAZA TFCA which is a multiple land use regional transboundary conservation initiative with a common vision of promoting and supporting sustainable livelihoods through coexistence and utilisation of multiple resource and resources areas, including national parks, game reserves, forest reserves, conservancies, game/wildlife management areas and communal lands livelihoods that are dependent on seasonal subsistence agriculture, animal husbandry, fishing, natural resource harvesting, tourism, trading and hunting. The development of the subsurface resources under KAZA TFCA is not and cannot, in any way be excluded from this visionary multiple land use transboundary initiatives especially where there is opportunity for coexistence. With exception of the formally proclaimed national parks in Namibia, there is no prohibition on the subsurface resources exploration or utilisation within the KAZA TFCA portion of the Namibian territory.

The proposed 2D seismic survey area and the AOI is not situated in the active catchment areas of the Okavango River basin but in fossil channels of the Omatako’ Omuramba Ephemeral rivers with no surface flow into the Okavango River. Overall, the key central exploration interests are situated about 80 km south of the Okavango River and more than 260 km from the Okavango Delta in Botswana and not related to the active catchment area of the Okavango Delta whatsoever. The overall general area falls in the sparsely populated but not pristine communal areas of the Ncamangoro and Mashare Constituencies of the Kavango West and East Regions, respectively. Ncamangoro and Mashare Constituencies falls within the boundaries of the Mbunza and Sambuyu Traditional Authorities, respectively.

All human induced activities including the current land uses such as subsistence agriculture, animal husbandry, natural resource harvesting, conservation, and tourism and the proposed 2D seismic survey operations, have the potential to cause negative consequences on the receiving physical, biological, socioeconomic, cultural, and archaeological environments. By identifying the most important sensitivity components of the receiving environment including high risk habitats beforehand, coupled with environmentally acceptable recommendations (mitigating factors), the overall negative impacts are likely to be minimised, while the positive impacts may be enhanced. The following is the summary of the identified positive and negative components of the receiving environment that have been evaluated and assessed with respect to the proposed 2D seismic survey operations:

(i) Possible positive impacts: Payment of rental license fees, contributions to the PetroFund, short-term contractual employment opportunities, contribution to national subsurface knowledge-base and support to rural water supply through Corporate Social Responsibility (CSR), and cumulative impacts, and.

(ii) Possible receptors likely to be negatively impacted: Habitats, reptiles, amphibians, mammals, avian, tree, shrub species, grass, socioeconomic, existing infrastructure, current and future land uses, ecosystem functions, services, use values and non-use or passive use, physiography and geology, visual and land degradation, surface and groundwater quality, increased water consumption / depletion of water resources, existing local community water supply infrastructure along the proposed survey lines (existing roads and tracks), community and workers security, public safety, Occupational Health, and Safety, noise and vibrations, dust and air quality, waste (solid and liquid) management, accidental events, archaeological, paleontological, and historical resources, contributions to global Climate Change, and cumulative impacts.

The Proposed 2D seismic survey will have high positive impacts on the socioeconomic environment at national, regional and community levels. The overall severity of potential negative environmental impacts of the proposed 2D seismic survey activities on the receiving environment will likely be of low magnitude, temporally duration, localised extent, and low probability of occurrence due to the limited scope of the proposed activities to be conducted along existing roads and tracks.
Mitigation measures have been recommended and are contained in a separate EMP Report for the proposed project. Through the effective implementation and monitoring of the recommended mitigation measures, the overall likely negative impacts of the proposed 2D ground seismic survey activities on the receiving environment (physical, socioeconomic, and biological) will likely to be low and localised with negligible significant impact.

7.2 Recommendations

The following is summary of recommendations to be implemented by the Proponent with respect to the key selected proposed project components:

(i) Project Location: The location of the proposed profiles / survey lines are based on the findings of the detailed field-based survey / scouting activities that were undertaken by the Proponent and verified by Risk-Based Solutions team during the months of December 2020 and January 2021 in order to assess alternative profiles routes. The proposed survey lines follow already existing roads and tracks. Some minor tracks may require limited clearing / widening along certain sections to allow for the survey trucks to pass easily. Trees and low vegetation shall not be cut unnecessary. Various alternative tracks and roads aligned in the north-south and east-west directions do exist within the survey area and must be used to avoid unnecessary cutting of vegetation and disturbance / disruption of pristine habitats.

(ii) Cutlines: No new cutlines shall be made and all survey lines must follow the existing roads, tracks or paths or already disturbed areas that will require minimum vegetation clearing.

(iii) Temporary Campsite: Accommodation for the exploration team shall be provided at a fly campsites within the survey area. The campsite requirements shall use the current drilling location campsite areas as much as it is logistically possible. All new fly camp areas if outside the current drilling location camp sites shall be situated on already disturbed areas such as unused previous agricultural field after obtaining written permission and signing of a formal Lease Agreement with the land owner.

(iv) Freshwater supply shall be provided from the existing infrastructures in the general areas and there will be no need of drilling a new water supply borehole/s specific for the proposed 2D seismic survey operations. The drilling locations within the survey area all have dedicated water supply boreholes for the project. Bottled drinking water shall be provided around the campsite and along the survey lines / profiles.

(v) Source of energy shall be supplied from renewable solar installation or generator as may be required.

(vi) Waste water management must utilise mobile chemical toilet system around the campsite and along the survey lines / profiles. A French drain is also a suitable alternative that may be used for the campsite area. The designs for such a French Drain shall be approved by the Department of Water Affairs in the Ministry of Agriculture and Land Reform.

(vii) Solid Waste Management: Very small amount of solid waste is expected to be generated during the planning and mobilisation, data acquisition, demobilisation, and abandonment stages of the proposed 2D seismic survey operations. Waste disposal bags / containers must be provided and visible around the campsite and along the survey lines / profiles. Littering around the campsite and along the survey lines / profiles is strictly prohibited. Waste minimisation and reduction, re-use and recycling are highly encouraged and awareness raising must be undertaken on a continuous basis and the team must always be reminded of their obligations towards effective waste management practices and overall environmental management during each and every debriefing session, and.

(viii) A targeted and transparent local recruitment process must be put in place by the Proponent to avoid unnecessary high job expectation from the local community as well as manage potential job recruitment scams targeting local communities.
Based on the findings of this EIA Report and the recommended mitigation measures detailed in the EMP Report, it is hereby recommended that the proposed 2D ground seismic survey over the key Areas of Interest (AOI) in PEL No. 73 shall be issued with an Environmental Clearance Certificate (ECC) with the following key conditions:

1) The Proponent must adhere to the provisions of all the national legislation, regulations, policies, procedures and permits / authorisation requirements.

2) The proponent shall adhere to all the provisions of the EMP and mitigation measures shall be implemented and monitored.

3) Before the implementation of the proposed 2D ground seismic survey operations, the Proponent shall consult with the local community / owners of the communal fields that may be used or likely to be disturbed by the proposed project activities. All the consultations shall be undertaken through the Office of the Governor for Kavango West and West, local Councillors and / Traditional Authorities, and.

4) Written consent shall always be obtained from the land owners and local community through the traditional authorities, and regional council as may be applicable to avoid misunderstanding and unnecessary conflicts.
8. REFERENCES

1. GENERAL FURTHER READING


Cunningham P. 2021. Flora and Fauna specialist Report to the EIA and EMP Reports for the proposed 2D seismic survey in PEL 73, Kavango East and West regions.


Julius A., 2021. Water Resources (Geology, Hydrology and Hydrogeology) specialist consultant chapters / sections contributions to the EIA and EMP Reports for the proposed 2D seismic survey in PEL 73, Kavango East and West regions.


Nankela A., 2021. Archaeological specialist consultant chapters / sections contributions to the EIA and EMP Reports for the proposed 2D seismic survey in PEL 73, Kavango East and West regions.


Sanzila. M. 2021. Public and stakeholder consultation and engagement specialist consultant chapters / sections contributions to the EIA and EMP Reports for the proposed 2D seismic survey in PEL 73, Kavango East and West regions.


Stankevica V., 2021. Socioeconomic specialist consultant chapters / sections contributions to the EIA and EMP Reports for the proposed 2D seismic survey in PEL 73, Kavango East and West regions.

Sylvanus O. A., 2021. Environmental, aerosol, noise, occupation and safety specialist consultant chapters / sections contributions to the EIA and EMP Reports for the proposed 2D seismic survey in PEL 73, Kavango East and West regions.


2. SOCIOECONOMIC FURTHER READING


3. **ARCHAEOLOGY FURTHER READING**


8. ANNEXES

1. Final Environmental Scoping Report Vol. 1 of 3
2. Fauna and Flora Specialist Report
3. Public and stakeholder consultation materials
4. CVs of the EAP and Specialist Consultants
1. Final Environmental Scoping Report Vol. 1 of 3
Final Environmental Scoping Report to Support the Application for Environmental Clearance Certificate (ECC) for the Proposed 2D Seismic Survey covering the Areas of Interest (AOI) in Petroleum Exploration License (PEL) No. 73, Kavango Sedimentary Basin, Kavango West and East Regions, Northern Namibia
OPERATOR
Reconnaissance Energy Namibia (Pty) Ltd Subsidiary of Reconnaissance Energy Africa Ltd (ReconAfrica)

LICENSE PEL 73
Blocks 1719, 1720, 1721, 1819, 1820 and 1821

WORKING INTERESTS
ReconAfrica owns 90%
National Petroleum Corporation of Namibia (Namcor)
(A State-Owned Company) 10% with costs carried to the development stage

TYPE OF PETROLEUM EXPLORATION OPERATIONS
2D Seismic Survey Operations

ECC REFERENCE APPLICATION No.
APP-002250

PROPOSER NAMIBIAN ADDRESS
C/o Pioneer Oil and Gas Consulting
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WINDHOEK, NAMIBIA
admin@reconafrica.com

PROPOSER OVERSEAS ADDRESS
Berkeley Square House, Berkeley Square
London UK W1J 6BD
UNITED KINGDOM

ENVIRONMENTAL CONSULTANTS
Risk-Based Solutions (RBS) CC
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Tel: +264 - 61- 306058; FaxMail: +264-886561821
Mobile: +264-811413229 /812772546; Email: smwiya@rbs.com.na
Global Office / URL: www.rbs.com.na

ENVIRONMENTAL ASSESSMENT PRACTITIONER (EAP)
Dr Sindila Mwiya (PhD, PG Cert, MPhil, BEng (Hons), Pr Eng)

CITATION: Risk-Based Solutions (RBS), 2021. Final Environmental Scoping Report, Report to Support the Application for Environmental Clearance Certificate (ECC) for the Proposed 2D Seismic Survey covering the Area of Interest (AOI) in Petroleum Exploration License (PEL) No. 73, Kavango Sedimentary Basin, Kavango West and East Regions, Northern Namibia.
<table>
<thead>
<tr>
<th>Name</th>
<th>Project Role / Position / Specialisation</th>
<th>Affiliation / Company</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr Sindila Mwiya</td>
<td>Environmental Assessment Practitioner (EAP), Engineering Geology / Geotechnical / Geoenvironmental / Environmental Engineering, Artificial Intelligence and Knowledge-Based Systems with special focus on EIAs, EMPs, EMSs, SEAs and SEMP s with respect to subsurface resources (minerals, petroleum, water) and energy in Arid and Semiarid Environments (Engineering and Environmental Geologist).</td>
<td>Risk-Based Solutions (RBS) CC</td>
</tr>
<tr>
<td>Dr Vita Stankevica</td>
<td>Socioeconomic and Quality Control Project Specialist Consultant</td>
<td>Risk-Based Solutions (RBS) CC</td>
</tr>
<tr>
<td>Dr Onjefu Sylvanus Ameh</td>
<td>Environmental, Aerosol, Noise, Radiation and Occupation and Safety Project Specialist Consultant</td>
<td>Risk-Based Solutions (RBS) CC</td>
</tr>
<tr>
<td>Peter Cunningham</td>
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<td>Marvin Environmental Projects Consultants CC</td>
</tr>
</tbody>
</table>
I Dr Sindila Mwiya, the EAP for this Environmental Assessment process conducted to support the application for Environmental Clearance Certificate (ECC) for the proposed 2D seismic survey operations over the Areas of Interest in the Petroleum Exploration License (PEL) No. 73, Kavango Sedimentary Basin, Kavango West and East Regions for Reconnaissance Energy Namibia (Pty) Ltd (Proponent), hereby declares that:


2. As an EAP for this ECC application, I am highly qualified and experienced and hold a PhD with research interests, academic training and knowledge in Engineering Geology / Geotechnical / Geoenvironmental / Environmental Engineering, Artificial Intelligence and Knowledge-Based Systems with special focus on EIAs, EMPs, EMSs, SEAs and SEMP with respect to subsurface resources (minerals, petroleum, water) and energy in Arid and Semiarid Environments (Engineering and Environmental Geologist).

3. I have knowledge and experience in conducting environmental assessments, management, and monitoring, and have undertaken more than 200 projects since 2004, including more than 55 oil and gas exploration and production related environmental assessments, management, and monitoring projects in different parts of the World.

4. I have performed the work relating to this ECC application in an objective manner, even if the outcomes will result in views or Records of Decision that may not be favourable to the Interested and Affected Parties (I&APs) or the Proponent.

5. I am an independent consultant not related to the Proponent, I co-own and operate an independent company (Risk-Based Solutions CC) not related to the Proponent and I have no shares, interests, or involvement in the license, financial or other affairs or business or operational decisions of either the Proponent or the decision-making structures of the relevant Government institutions.

Dr Sindila MWIYA
Environmental Assessment Practitioner (EAP)
RISK-BASED SOLUTIONS (RBS) CC


3. **NOISE, VIBRATION, DUST, HEALTH AND SAFETY FURTHER READING**

Chauhan S.S., Mining, development and environment: A case study of Bijolia mining area in Rajasthan, India


SANS, The measurement and rating of environmental noise with respect to land use, health, annoyance and speech communication, South African National Standard SANS 1929:2005 (2005)


4. **FURTHER READING ON FAUNA AND FLORA (SEE ANNEX 2)**
STATEMENT OF QUALIFICATIONS OF THE ENVIRONMENTAL ASSESSMENT PRACTITIONER (EAP) – DR SINDILA MWIYA

Dr Sindila Mwiya has more than eighteen (18) years of practical field-based technical industry experience in Environmental Assessment (SEA, EIA, EMP, EMS), Energy (Renewable and Non-renewable energy sources), onshore and offshore resources (minerals, oil, gas and water) exploration / prospecting, operation and utilisation, covering general and specialist technical exploration and recovery support, Health, Safety and Environment (HSE) permitting for Geophysical Surveys such as 2D, 3D and 4D Seismic, Gravity and Electromagnetic Surveys in mining, energy and petroleum (oil and gas) operations support, through to engineering planning, layout, designing, logistical support, recovery, production / operations, compliance monitoring, rehabilitation, closure and aftercare projects lifecycles. He continues to work internationally in the resources (mining and petroleum) and energy sectors, from permitting through to exploration and production. From the frontier regions (high risk hydrocarbons exploration zones) of South Africa and Namibia, to the prolific oil and gas fields of the Middle East, Angola and the West African Gulf of Guinea, Dr Mwiya has been directly involved in field-based aerial, ground and marine geophysical (gravity, magnetics and seismic) surveys, been on-board exploration drilling rigs, onboard production platform, conducted public and stakeholder consultations and engagements, and worked with highly technical and well organised and committed clients and third-party teams from emerging and well-established global resources and energy companies from many countries such as the UK, France, USA, Russia, Canada, Croatia, Norway, the Netherlands, Spain, Brazil, China, South Africa, Equatorial Guinea, Angola and Nigeria. He is fully aware of all the competing interests and niche donation-based business environmental advocacy opportunism that exists in the resources sector from the local, regional, and international perspectives.

Through his companies, Risk-Based Solutions (RBS) CC and Foresight Group Namibia (FGN) (Pty) Ltd which he founded, he has undertaken more than 200 projects for Global (Namibia), Continental (Angola and International (Global) based clients. He has worked and continue to work for Global; Continental and Namibian based reputable resources (petroleum and mining / minerals) and energy companies such as Dundee Precious Metals (Namibia / Canada), Headspring Investment (Namibia/ Russia), Green Energy (Namibia/Russia), EMGS (UK/ Norway), Lepidico (Australia / UK), Best Sheer / Bohale (Namibia / China), CCG Services UK Limited (UK/ France/Namibia), BO Offshore (Norway/Singapore /Namibia), Shell Namibia B. V. Limited (Namibia/ the Netherlands), Tullow Oil (UK/Namibia), Debjmarine (DBMN) (Namibia), Reconnaissance Energy Africa Ltd (ReconAfrica) (UK/Cana/Namibia), Osino Resource Corporation (Canada/USA/Namibia), Petrobras Oil and Gas (Brazil) / (BP) / (UK)/ Namibia, REPSOL (Spain / Namibia), ACERES Exploration (UK), Hydrocarbon Solutions (Namibia), HRT Africa (Charter), Usipa Resources (Pty) Ltd (Namibia), Serica Energy (UK/ Namibia), Eco (Atlantic) Oil and Gas (Canada / USA/ Namibia), ION GeoVentures (USA), PGS UK Exploration (UK), TGS-Nopec (UK), Maurel & Prom (France/ Namibia), GeoPartners (UK), PetroSA Geophysical Equatorial South Africa (Equatorial Guinea / Namibia), Preview Energy Resources (Namibia / UK), Sinteznentegaz Namibia Ltd (Russia/ Namibia), INA Namibia (INA INDUSTRIJA NAFTE d.d) (Croatia/ Namibia), Namibia Underwater Technologies (NUTAM) (South Africa/Namibia), InnoSun Holdings (Pty) Ltd and all its subsidiary renewable energy companies and projects in Namibia (Namibia / France), HopSol (Namibia/Switzerland), Momentous Solar One (Pty) Ltd (Namibia / Canada); OLC Northern Sun Energy (Pty) Ltd (Namibia) and more than 100 local companies. Dr Sindila Mwiya is highly qualified with extensive practical field-based experience in petroleum, mining, renewable energy (Solar, Wind, Biomas, Geothermal, carbon, Hydrogen, and hydropower), Non-Renewable energy (Coal, Petroleum, and Natural Gas), applied environmental assessment, management, and monitoring (Scoping, EIA, EMP, EMP, EMS) and overall industry specific HSE, cleaner production programmes, Geoenvironmental, geological and geotechnical engineering specialist.

Dr Sindila Mwiya has undertaken and continue to undertake and manage high value projects on behalf of global and local resources and energy companies. Currently, (2020-2023) Dr Sindila Mwiya is responsible for permitting planning through to operational and compliance management, permitting / Technical Consultant (RBS / FGN), Project Manager, Programme Advisor for the Department of Natural and Applied Sciences, Namibia University of Science and Technology (NUST) and has worked as a Lecturer, University of Namibia (UNAM), External Examiner/ Moderator, NUST, National (Namibian) Advisor (Directed Environmental Assessment, Forestry, Tourism and Town and Country Planning Component) and Chief Geologist for Engineering and Environment Division, Geological Survey of Namibia, Ministry of Mines and Energy and a Field-Based Geotechnician (Specialised in Magnetics, Seismic, Gravity and Electromagnetics Exploration and Survey Methods) under the Federal Institute for Geosience and Natural Resources (BGR) German Mineral Exploration Promotion Project to Namibia, Geophysics Division, Geological Survey of Namibia, Ministry of Mines and Energy.

He has supervised and continue to support a number of MScs and PhDs research programmes and has been a reviewer on international, national and regional researches, plans, programmes and projects with the objective to ensure substantial local skills development, pivotal to the national socioeconomic development through the promotion of sustainable natural resources coexistence, management, development, recovery, utilisation and for development policies, plans, programmes and projects financed by governments, private investors and Namibian development partners. Since 2006 until 2017, he has provided extensive technical support to the Department of Environmental Affairs (DEA), Ministry of Environment, Forestry and Tourism (MEFT) through GIZ in the preparation and amendments of the Namibian Environmental Management Act, 2007, (Act No. 7 of 2007), Strategic Environmental Assessment (SEA) Regulations, Environmental Impact Assessment (EIA) Regulations as well as the SEA and EIA Guidelines and Procedures all aimed at promoting effective environmental assessment and management practices in Namibia.

Among his academic achievements, Dr Sindila Mwiya is a holder of a PhD within the broader fields of Engineering Geology/Geotechnical / Geoenvironmental / Environmental Engineering and Artificial Intelligence with a research thesis titled Development of a Knowledge-Based System Methodology (KBSM) for the Design of Solid Waste Disposal Sites in Arid and Semi-arid Environments, MPH/PG Cert and BEng (Hons) (Engineering Geology and Geotechnics) qualifications from the University of Portsmouth, School of Earth and Environmental Sciences, United Kingdom. During the 2004 Namibia National Science Awards, organised by the Namibian Ministry of Education, and held in Windhoek, Dr Sindila Mwiya was awarded the Geologist of the Year for 2004, in the professional category. Furthermore, as part of his professional career recognition, Dr Sindila Mwiya is a life member of the Geological Society of Namibia, Consulting member of the Hydrogeological Society of Namibia and a Professional Engineer registered with the Engineering Council of Namibia.
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Non-Technical Summary

Reconnaissance Energy Namibia (Pty) Ltd, which is a subsidiary of Reconnaissance Energy Africa Ltd (ReconAfrica), a Canadian public listed company, holds petroleum exploration rights under the Petroleum Exploration License (PEL) No. 73 covering Degree Square Blocks 1719, 1720, 1721, 1819, 1820 and 1821 over the newly discovered Kavango Sedimentary Basin, Kavango West and East regions in northern Namibia. PEL 73 is granted under Section 29-38 of the Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991) administered by the Ministry of Mines and Energy (MME) as the Competent Authority. ReconAfrica is the Operator of PEL 73 holding 90% of the license interests and the remaining 10% is held by the National Petroleum Corporation of Namibia (Namcor) with its costs carried to the development stage. As part of the provisions of the Petroleum Agreement signed between ReconAfrica and the Government of the Republic of Namibia represented by the Ministry of Mines and Energy (MME), ReconAfrica has committed to undertaking petroleum exploration activities in PEL 73. The Petroleum Agreement provides for the initial exploration period (4 years), first and second two (2) years renewal exploration periods subject to possible one-year extension. In an event of discovery of economic oil and gas reserves, the Company may apply for a 25-year production license, which should be granted within 6 months of the date of application.

Petroleum exploration involves the implementation of multiple exploration steps over many years and each major step requires a separate environmental assessment processes to be conducted as provided for in Environmental Protection Clause 11 of the Petroleum Agreement signed between ReconAfrica and the Government of the Republic of Namibia, Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991), Petroleum Laws Amendment Act, 1998, (Act 24 of 1998), the Environmental Management Act, 2007, (Act No. 7 of 2007) and all other applicable national laws and Regulations subject to the type of exploration activities being undertaken at any given time. In fulfilment of the environmental requirements, ReconAfrica (the Proponent) has appointed Risk-Based Solutions (RBS) CC as the Environmental Consultant and led by Dr Sindila Mwiya as the Environmental Assessment Practitioner (EAP) to undertake the Scoping, Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) to support the application for Environmental Clearance Certificate (ECC) for the proposed 2D seismic survey operations.

To date ReconAfrica has delineated the Kavango Basin as key exploration Area of Interest (AOI) based on the interpretation of the available Government high resolution aerial geophysical data, regional structural geology, and historical well data from the Etosha Basin. In order to confirm the presence of an active petroleum system and the existing of the Kavango Basin, stratigraphic wells will be drilled to study the geology of the AOI. Following on the drilling of the stratigraphic wells, the company intends to conduct 450 km long of 2D seismic survey operations over the AOI within the Kavango in order to search for hydrocarbon structural reservoirs with the potential for holding hydrocarbon resources. Depending on the outcomes of the proposed 2D seismic survey operations, exploratory drilling operations over the delineated hydrocarbon structural reservoirs may be undertaken over the AOI.

The scope of this environmental assessment only covers the exploration phase and specifically focusing on the proposed 2D seismic survey operations and has nothing do with the production stages to which no oil or gas has so far been discovered. The Environmental Assessment process for the proposed 2D seismic survey inclusive of this Scoping Report, has taken into consideration the public and stakeholder consultation requirements, sensitivity of the receiving environment (physical, biological, socioeconomic and ecosystem services and functions) with respect to the following operational stages likely to be key sources of impacts associated with the proposed 2D seismic survey:

(i) Planning and mobilisation (Pre-survey preparation).

(ii) Camp sites setups and widening of tracks and creation of limited new access as may be applicable or requested by the local community under the Corporate Social Responsibility.

(iii) Actual data acquisition, and.

(iv) Demobilisation (survey completion).
2D seismic survey is an environmentally friendly nonintrusive geophysical method used for mapping or imaging of the subsurface geology. During the seismic survey, the weigh drop generated seismic wave which travels into the earth gets reflected by various subsurface formations, and returns to the surface where it is recorded by the receivers called geophones. The resultant product following complex processing is a vertical sonic cross-section of the subsurface beneath the survey line showing the geological materials (de-risked geological sub model) and structures that the acoustic wave has travelled through. This information is used to predict potential areas where oil or gas may be trapped in sufficient quantities for further exploration activities such as drilling of an exploration well.

The proposed survey operations covering the key exploration Areas of Interest (AOI) within PEL 73 will be conducted along existing roads and tracks, using the Explorer 860 Accelerated Weight Drop (AWD) energy sources and wireless receivers. The weight-drop which generates a thump as it hits the ground is not expected to have any frequency specific interference with the natural receiving environment.

Although PEL 73 and the AOI falls within the In Namibia and in other KAZA TFCA member states, the exploration and utilisation of potential subsurface resources under KAZA TFCA, are allowed, except in the formally national member state proclaimed sensitive areas such as national parks. Sensitive areas within the Namibian portion of KAZA TFCA are known and the proposed 2D seismic survey operations in PEL 73 does not fall in such sensitive area such as a national park, legally excluded from oil and gas exploration. The AOI interests does not fall in an environmental proclaimed protected or sensitive area nor in groundwater protection zone. The key central exploration interests are situated about 55 km south of Rundu, 80 km south of the Okavango River, more than 260 km from the Okavango Delta in Botswana and not related to the Delta whatsoever, more than 40 km from the boundary of the Khaudum National Park and more than 70 km from the Mangetti National Park. The overall general area falls in the sparsely populated but not pristine communal areas of the Ncamangoro and Mashare Constituencies of the Kavango West and East Regions, respectively. Ncamangoro and Mashare Constituencies falls within the boundaries of the Mbunza and Sambyu Traditional Authorities, respectively.

It is estimated that at least 67 species of reptile, 32 amphibian, 116 mammal and 210 bird species (breeding residents) are known to or expected to occur in the general Kavango and West East regions of the proposed project area. It is estimated that at least 107 species of larger trees and shrubs (>1m in height) and up to 111 species of grasses are known to or expected to occur in the general area, none of which are viewed as endemic species. A group of archaeological heritage sites within the general area but not necessary within the AOI are known to exist along the Omatako River basin between Ncute and Taratara villages and south west of Omatako River basin. These sites will not be impacted by the proposed 2D seismic survey operations neither are they vulnerable nor sensitive. The land uses in the general area is mainly communal / subsistence farming comprising cattle, donkeys, seasonal crop farming, grass, and wood / timber harvesting. The following is the summary of some of the common current threats to the natural environment and habitats of the general project area inclusive of the AOI and the area covered by the proposed 2D seismic survey operations:

(i) Accelerated allocation of communal leaseholds resulting in forestry clearing.
(ii) Subsistence communal crop farming centred on forestry clearing, slash and burn practices.
(iii) Increase in wildfires, timber and wood harvesting, and.
(iv) Overgrazing due to increased number of animals.

Based on the findings of this Environmental Scoping report, the EIA and EMP reports have been prepared to support the application for ECC for the proposed 2D seismic survey operations over the areas of interest within PEL 73. The EIA and EMP process included the following site-specific specialist studies: Field-based flora and fauna and other specialist contributions to the various sections of the EIA and EMP Reports through independent desktop reviews of published materials on water, archaeological, dust, noise, and socioeconomic. Public and stakeholder consultation process were organised as part of the environmental assessment process for the proposed 2D seismic survey operations in PEL 73. Details of the consultation activities undertaken are covered in the EIA Report and included in Annex 3.
1. PROJECT BACKGROUND

1.1 Introduction

Reconnaissance Energy Namibia (Pty) Ltd, herein referred as ReconAfrica holds petroleum exploration rights under the Petroleum Exploration License (PEL) No. 73 covering Degree Square Blocks 1719, 1720, 1721, 1819, 1820 and 1821 in Kavango Sedimentary Basin, Kavango West and East regions, northern Namibia (Figs. 1.1 and 1.2). PEL 73 is granted under Section 29-38 of the Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991) administered by the Ministry of Mines and Energy (MME) as the Competent Authority. Reconnaissance Energy Namibia (Pty) Ltd, is a subsidiary of Reconnaissance Energy Africa Ltd (ReconAfrica), a Canadian public listed company. ReconAfrica is the Operator of PEL 73 holding 90% of the license interests. The National Petroleum Corporation of Namibia (Namcor), a Namibian State-owned company (Parastatal) holds the remaining 10% interest in the Licence, with its costs carried to the development stage.

As part of the provisions of the Petroleum Agreement signed between ReconAfrica and the Government of the Republic of Namibia represented by the Ministry of Mines and Energy (MME), ReconAfrica has committed to undertaking petroleum exploration activities in PEL 73. Petroleum exploration involves the implementation of multiple exploration steps over many years and each of the following summarised steps 2-5 requires separate environmental assessment processes to be conducted as provided for in Environmental Protection Clause 11 of the Petroleum Agreement, Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991), Petroleum Laws Amendment Act, 1998, (Act 24 of 1998), the Environmental Management Act, 2007, (Act No. 7 of 2007) and all other applicable national laws and Regulations subject to the type of exploration activities being undertaken at any given time:

1. **Step 1**: An applicant develops a theoretical hydrocarbon model and apply for a Petroleum Exploration License (PEL) and once the license is granted there is no requirement for undertaking environmental assessment and obtaining the Environmental Clearance Certificate (ECC) over the entire license area. The environmental assessment and all other permitting are only required once the PEL holder decides to implement exploration activities such as drilling or seismic survey that are listed in the applicable laws or may require other permits as may be applicable.

2. **Step 2**: Collection of the existing key historical data sets pertaining to petroleum geology, sedimentary basin, aerial gravity, magnetics and if the sedimentary basin is unknown, a site-specific stratigraphic well/s drilling operation is undertaken in order to confirm the existence of sedimentary basin / petroleum system delineated aerial geophysical data and other exiting geological data sets.

3. **Step 3**: Once the sedimentary basin has been confirmed and potential target area defined, ground geophysical surveys methods such as 2D seismic surveys are used in the search for potential geological structures that could hold economic oil or gas called reservoirs. This environmental assessment report covers this step 3.

4. **Step 4**: Exploration well drilling is undertaken on the identified geological structure (potential reservoir) based on the interpreted results of the seismic survey in order to test and confirm if the seismic survey delineated geological structure/s contains any economic oil or gas resources. If the drilled exploration well is dry it will be capped and abandoned safely, and.

5. **Step 5**: If there is oil or gas discovered during the exploration well drilling operations, then an appraisal well drilling operations may be undertaken in order to test the size and economics of the discovered oil or gas field. It is during the EIA for appraisal drilling for commercially discovered oil or gas and for possible production from either a conventional reservoir (with natural pores and permeability) or unconventional reservoir (natural pores but limited permeability) that one can now start to talk about fracking. At present Namibia has no commercial or economic or even indicative oil or gas discovered onshore to frightened the public about nonexistence planned fracking. Fracking is not an exploration drilling technique but an oil or gas production method applied after a commercial proved discovery in a reservoir with poor primary permeability.
Figure 1.1: Hydrocarbon Map of Namibia (Source: www.namcor.com.na or www.mme.gov.na). Petroleum Licenses are granted as degree (Latitude and Latitude) Square Blocks and several such license have been granted both in the offshore and onshore environments. Plenty more blocks are open for anyone to apply if one has about N$2million yearly payment to lease such an area from the State inclusive of all other required mandatory State contributions.
Figure 1.2: Regional location of PEL No. 73 covering degree squares Blocks 1719, 1720, 1721, 1819, 1820 and 1821 and showing the Areas of Interest (AOI) (Kavango Sedimentary Basin), the proposed 2D seismic survey lines, regional council constituencies and traditional authorities boundaries.
1.2 ReconAfrica Work Commitment and Obligations for PEL 73

1.2.1 Initial Exploration Period (4 years)

The initial exploration phase is a 4-year term with a one-year extension, with two potential renewal exploration extensions each of which are two years plus with an additional year extension. The spending commitment for the first phase was originally US$5 million plus an additional US$50,000 per year for the purpose of training and educating Namibians. In lieu of shooting a minimum 500 km of 2D seismic data, ReconAfrica had elected for a minimum two test wells to the base of the Karoo Super group. General market conditions allowed the Company to postpone the original program.

1.2.2 First Renewal Exploration Period

The first renewal exploration period of two (2) years is subject to possible one-year extension. In December 2019, the Company announced that its exploration license had been approved for the first renewal exploration period, which continues until January 25, 2022. During this period the Company must spend US$10 million, in addition to the US$50,000 per year for training and education for Namibians. The work program must acquire 250 kilometres of 2D seismic data and see the drilling and evaluation of either two (2) stratigraphic or exploration wells.

1.2.3 Second Renewal Exploration Period

The second renewal exploration period of two (2) years is subject to possible one-year extension. The second renewal period holds similar capital requirements and social programs to the first, with a requirement to acquire 200 km² of 3D seismic and drill and evaluate an initial delineation test.

1.2.4 Production License

If ReconAfrica’s exploration work leads to an economically viable project (discovery of economic oil and gas reserves), the Company may apply for a 25 year production license, which should be granted within 6 months of the date of application. The terms of the production license are a 5% royalty, and a 35% corporate tax rate. In addition, a three-tiered Additional Profits Tax (APT) is payable on the after-tax net cash if certain after tax, inflation adjusted rates of returns are met. The first hurdle rate is 15%, with the second and third tiers at 20% and 25%. Exploration, development and operating expenditures, as well as royalty and corporate income tax, are all fully deductible in the year they are paid in the computation of the APT net cash flow for the year. The first-tier rate of APT is established in the legislation (through a formula) at 25%. The incremental second and third tier APT rates are determined in the Petroleum Agreement, and in the case of Reconnaissance, are 28% and 29% respectively.

Note: The scope of this environmental assessment only covers the exploration phase and specifically focusing only on the proposed 2D seismic survey operations and has nothing do with the production phase and possible method/s of production because no oil or gas has been discovered and the unknown cannot be measured.

1.3 Current Exploration Status, Motivation and Purpose

1.3.1 Current Exploration Status

Subsequent to the grant in 2015 ReconAfrica purchased additional high resolution aeromagnetic data covering the Licensed Property and conducted a detailed analysis of the resulting data and other available data related to the block, including reprocessing and reinterpretation of all existing geological and geophysical data. This led to the identification of the Kavango Basin as the key Area of Interest within PEL 73. The company intends to conduct 450 km long 2D seismic survey operations as part of the its exploration commitments. The proposed survey operations will be conducted along existing roads and tracks, using the Explorer 860 as the surface energy source and wireless receivers or geophones. The overall aim and objective of conducting the proposed 2D seismic survey operations, is to search for geological structures called reservoirs that may contain economic hydrocarbon. Depending on the outcomes of the proposed 2D seismic survey operations, exploratory drilling
operations over the delineated hydrocarbon structural reservoirs may be undertaken followed by appraisal well drilling operations if there is a commercial oil or gas discovery.

1.3.2 2D Seismic Survey Influences on the Local Communities

Onshore seismic survey operations have been undertaken in Namibia before and the latest being the 2018 2D seismic survey conducted by Acrep in PEL 72 covering Kavango West Region. During any oil and gas exploration programme no community relocation whatsoever does takes place and no one will be relocated during the proposed 2D seismic survey operations to be conducted along existing roads and tracks. Community relocations are rarely undertaken and only during the oil or gas field development stages under the Production License following a commercial discovery. This may only happen if there are no coexistence opportunities / alternatives to be explored. Such instances may include; a community settlement located too close to a critical oil and gas supporting infrastructure that cannot be situated anywhere within the discovered oil or gas field. Such infrastructure may include a production well/s, pipeline, power station, refinery or any other supporting infrastructure to the oil or gas field development and operational safety requirements. Such issues will indeed be addressed in separate environmental assessment that may be implemented for the production phase of any discovered oil or gas resources.

1.3.3 Current Project Motivation

The proposed 2D ground seismic survey operations, has some limited and short-term socioeconomic benefits that includes: 3-4 months contractual employment opportunities for the local communities during the survey operations, the payment of the annual license rental fees to the Central Government and USD50, 000.00 annual contributions to the Petroleum Training and Education Fund (PETROFUND) for the duration of the exploration license. It is important to note that in the absence of any commercial discovery for oil and gas in Namibia, annual license fees and contributions to the PetroFund and averaging N$2 million per Degree Square Block per operator per year are a vital revenue streams for the State and for the benefit of all Namibians. The PetroFund provides local regional and international bursaries and scholarships to seventy (70) Namibians annually.

The seismic survey data to be generated will enrich the national geoscience database held by Namcor and will contribute to the understanding of the regional and local subsurface geology of both Kavango West and East Region. The seismic survey data to be generated will be highly useful in the search for minerals resources, water exploration, geothermal exploration and general geoscience research and development.

1.3.4 Purpose of this Scoping Report

This environmental assessment is focused only on assessing the environmental impacts associated with the proposed 2D seismic survey exploration method over an area of interest within the Kavango Basin, a very limited portion of PEL 73.

This environmental assessment study has nothing do with the conventional or unconventional production methods for oil and gas that does not exists because one cannot measure the unknown. If there is a commercial discovery, then yes, the environmental assessment studies that will follow for the appraisal and production phases will examine the environment friendliness of the type of production methods that may be used to produce the commercially discovered oil or gas and the opportunities for coexistence with current and future land uses.

The following is summary of the key guiding principles and objectives of the Environmental Assessment (EA) process and, this Scoping Report:

× Inform the public, stakeholders and Interested and Affected Parties (I&APs) about the proposed 2D seismic survey.

× Identify the main key affected communities and their concerns, and values.
Define the reasonable and practical alternatives to the proposed 2D seismic survey operations.

Identify the important issues with potential significant impacts on the receiving environment and guide the preparation of the Environmental Impact Assent (EIA) and Environmental Management Plan (EMP) reports to support the process of applying for Environmental Impact Assessment (EIA), and.

Define the boundaries for the EIA and EMP in terms of time, space, subject matter, and applicable specialist studies.

The overall approach to the preparation of this Scoping report covered the review of the receiving environment (physical, biological, socioeconomic and ecosystem services, function, use values and non-use) with respect to the proposed 2D seismic survey operations to identify the key issues to be addressed in the EIA and EMP reports.

1.4 Project Location

1.4.1 License Area (PEL), Exploration Areas of Interest and Oil or Gas Field

Although a PEL may be a very large area defined by the Degree Square Blocks which is good for the State in terms of the subsurface annual rental income, the key area of interest (Sedimentary Basin) is usually highly localised and controlled by the regional and local geology and petroleum system not the boundary of the license area and its proximity to a sensitive area (Figs 1.3 and 1.4). It is the proximity of the AIO or a discovered oil or gas field boundary to a sensitive area that is important. Within a PEL area, a local AOI is often delineated based on the interpretation of technical data and in an event of a commercial discovery, even more localised is the oil or gas field area within the AOI. Within the PEL, AOI or oil or gas field boundaries, only localised areas where the actual activities are taking place that defines the actual surface footprint of the operation with subsurface target/s situated very deep about 3-4km.

At present here there is no oil or gas discovery within AOI and there no oil or gas field boundary that has been delineated. An oil or gas field within an AOI can only be delineated following a commercial discovery and completion of an appraisal well drilling and testing operation before actual field development can even be contemplated. An oil and gas field is usually a localised area within the entire AOI which is used for producing oil or gas.

1.4.2 PEL 73 License Area

The PEL 73 which is granted as a Degree Square Blocks as provide for in the Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991) covers an area of approximately 25,341.33 sq km (6.3 million acres) (Fig. 1.3). PEL No. 73 covering Blocks 1719, 1720, 1721, 1819, 1820 and 1821 falls within the Kavango Basin forming part of the greater Etosha Basin of northern Namibia falling within the greater Kalahari Sediments of Southern Africa.

1.4.3 The Area of Interest (AOI) Within PEL 73

The Area of Interest (AOI) within PEL 73 delineated from the interpretation of the aerial geophysical data covering the Kavango West and East Regions is not on the banks of the Okavango River, not related to the Okavango Delta, does not cover the archaeological sites and Tsodilo Hill which is in Botswana and do not fall in sensitive or proclaimed national park.

Current key exploration interests in Kavango West and East Regions are situated about 55 km south of Rundu, 80 km south of the Okavango River, more than 260 km from the Okavango Delta in Botswana and not related to the Delta whatsoever, more than 40 km from the boundary of the Khaudum National Park.
Park and more than 70 km from the Mangetti National Park. The overall general area falls in the communal areas of the Ncamangoro and Mashare Constituencies of the Kavango West and East Regions, respectively. Ncamangoro and Mashare Constituencies falls within the boundaries of the Mbuza and Sambyu Traditional Authorities, respectively.

The proposed 2D seismic survey will cover the AOI not the entire PEL 73. Extension of the survey lines beyond the AOI will be undertaken only to fully understand the possible subsurface structural closures and search for potential reservoirs that may be associated with the basin margins (Fig. 1.3).

The environmental footprint of any ground-based oil and gas exploration operations is often the temporary campsite, operated less than 90 days and usually occupies an area ranging from 2 to 6 Ha (150m by 150m to 250m by 250m) depending on the type and size of the exploration operations.

Seismic survey operation is a nonintrusive exploration method used in validating the geologic sub model through imaging of the subsurface in the search for key geological structures that could hold oil or gas within a Sedimentary Basin.

The size of an oil and gas exploration well (actual hole drilled) differs from well to well, but is generally around 12.5 to 90 centimetres wide and this is the footprint made into the ground with targets as deep as 3 - 4 km.

Figure 1.3: Illustration of the size and exploration footprint over a License Area (PEL) (subsurface rental area), Sedimentary Basin exploration Area of Interest (AOI), Sedimentary Basin seismic survey area, Sedimentary Basin drilling location and oil or gas field in an event of a commercial discovery with respect to the de-risking / exploration process.
1.4.4 Location of the Proposed 2D Seismic Survey Lines

PEL 73 and the proposed 2D seismic survey area covers parts of both the Kavango West and East Regions in northern Namibia (Fig. 1.4). Within the key areas of interest, the following tribal (traditional) authorities falls within the Kavango East Region: Shambyu, Gciruku and Mbu Kushu tribal authorities (Fig. 1.4).

The following is the summary of the detailed locations of the proposed 2D seismic survey lines with respect to the regional and traditional authorities administrative / governance boundaries as shown in Figs. 1.2 and 1.4 and Plates 1.1 -1.32):

(i) Line NS-1: Covers Kavango East and West Regions; Ncuncuni, Ncamagoro and Mashare Constituencies; and Mbusza and Shambyu Traditional Authorities (Fig. 1.4 and Plates 1.1 -1.4).

(ii) Line NS-2: Covers Kavango East Region; Mashare Constituency; and Shambyu Traditional Authority (Fig. 1.4 and Plates 1.5 -1.8).

(iii) Line NS-3: Covers Kavango East Region; Ndiyona Constituency; and Gciruku Traditional Authority (Fig. 1.4 and Plate 1.9).

(iv) Line NS-4: Covers Kavango East Region; Mashare and Ndonga Linena Constituencies; and Shambyu Traditional Authority (Fig. 1.4 and Plates 1.10 and 1.11).

(v) Line NS-5: Covers Kavango East Region; Rundu Rural Constituency; and Shambyu Traditional Authority Fig. 1.4 and Plates 1.12 -1.14).

(vi) Line EW-1: Covers Kavango East and West Regions; Ncuncuni, Rundu Rural and Mashare Constituencies; and Mbusza and Shambyu Traditional Authorities (Fig. 1.4 and Plates 1.15 -1.17).

(vii) Line EW-2: Covers Kavango East Region; Mashare Ndonga Linena and Ndiyona Constituencies; and Shambyu and Gciruku Traditional Authorities (Fig. 1.4 and Plates 1.18-1.20).

(viii) Line EW-3: Covers Kavango East and West Regions; Ncuncuni, Rundu Rural and Mashare Constituencies; and Mbusza and Shambyu Traditional Authorities (Fig. 1.4 and Plates 1.21 -1.25).

(ix) Line EW-4: Covers Kavango West Region; Ncuncuni Constituency and Mbuza Traditional Authority (Fig. 1.4 and Plates 1.26 -1.28).

(x) Line EW-5: Covers Kavango West and East Regions; Ncamagoro, Ncuncuni and Mashare Constituencies and Mbusza and Shambyu Traditional Authorities (Fig. 1.4 and Plates 1.29-1.31), and.

(xi) Plate 1.32 shows one of the alternatives survey line EW with other alternative survey lines shown in Fig. 1.4.

1.4.5 Accessibility

The main access to the survey area can be undertaken by 4 by 4 vehicles either through the already exiting gravel roads, sandy roads and tracks connecting small settlement (Figs. 1.4 and 1.5 and Plates 1.1 -1.32). The survey area and all the profiles / survey lines do follow existing road or tracks (Fig. 1.4 and Plates 1.1 -1.32). Very few areas along the survey lines will require the widening of the existing sandy access resulting in cutting of the local bushes.
No big trees shall be cut unnecessary because of widening access because no new cut line will be created. The survey will be conducted from the month of April which is the dry season with no effect on the local subsistence farmland. The location of the proposed profiles / survey lines follows existing tracks and are based on the results of the field-based scouting and verification undertaken by Risk-Based Solutions team during the months of November and December 2020 and January 2021 (Plates 1.1-1.32).

1.4.6 2D Seismic Survey Operations and Alleged Communities Relocations

Onshore seismic survey operations have been undertaken in Namibia for many years and the latest being the 2017 2D seismic survey operations that was conducted by ACREP in PEL 72 covering Kavango West Region. During any oil and gas exploration programme no community relocation whatsoever does takes place and no one will be relocated or displaced during the proposed 2D seismic survey operations to be conducted along existing roads and tracks.

Community relocations are rarely undertaken even during the oil or gas field development stages following a commercial discovery and such instances may only affect a community settlement that may be located too close to a critical oil and gas supporting infrastructure that cannot be situated anywhere within the discovered oil or gas field.

Such infrastructure may include a production well/s, pipeline, power station, refinery or any other supporting infrastructure to the oil or gas field development and operational safety requirements. Such issues will indeed be addressed in a separate environmental assessment that may be implemented for the production phase of any discovered oil or gas resources.
Figure 1.4: Detailed location of the key exploration Areas of Interest (AOI) and proposed and alternative 2D seismic survey lines along exiting roads and tracks with respect to the various regional and traditional authorities and settlements.
Figure 1.5: Field-based verified existing access roads and tracks to be used for the proposed 2D seismic survey lines.
Plate 1.1: Northern section of the proposed 2D seismic survey Line NS-1 detailed location shown by a drone aerial view to the south along the D3425 road from Rundu to Ncaute.
Plate 1.2: Middle section of the proposed 2D seismic survey Line NS-1 detailed location near Hamoye shown by a drone aerial view to the south along the D3425 road from Rundu to Ncaute.
Plate 1.3: Southern middle section of the proposed 2D seismic survey Line NS-1 detailed location shown by a drone aerial view to the north (towards Ncaute) along the D3425 road near Gcaru and west of the Omatako Ephemeral River Channel.
Plate 1.4: Southern end-section of the proposed 2D seismic survey Line NS-1 detailed location shown by a drone aerial view to the north along the D3425 road near Namkaub junction of the track leading to the northern boundary of the Mangetti National Park.
Plate 1.5: Northern section of the proposed 2D seismic survey Line NS-2 detailed location shown by a drone aerial view to the north (towards Dove) along the existing tracks linking Dove to the D3400.
Plate 1.6: Northern section of the proposed 2D seismic survey Line NS-2 detailed location shown by a drone aerial view to the south (towards D3400 Road junction) along the existing tracks linking Dove to the D3400.
Plate 1.7: Middle section of the proposed 2D seismic survey Line NS-2 detailed location shown by a drone aerial view to the north along the D3400 Road towards junction with the existing tracks linking Dove to the D3400.
Plate 1.8: Middle section of the proposed 2D seismic survey Line NS-2 detailed location shown by a drone aerial view to the south along the existing track linked to the D3400.
Plate 1.9: Northern section of the proposed 2D seismic survey Line NS-3 detailed location shown by a drone aerial view to the south along the existing 4 by 4 sandy track linking Khaudum National Park to the B8 at Katere.
Plate 1.10: Northern section of the proposed 2D seismic survey Line NS-4 detailed location shown by a drone aerial view to the south along the D3400 linked to the B8.
Plate 1.11: Middle section of the proposed 2D seismic survey Line NS-4 detailed location shown by a drone aerial view to the south along the D3400 linked to the B8.
Plate 1.12: Northern section of the proposed 2D seismic survey Line NS-5 detailed location shown by a drone aerial view to the south along the new Rundu to Mbambi Roads D3448.
Plate 1.13: Middle section of the proposed 2D seismic survey Line NS-5 detailed location shown by a drone ground view to the east showing the new Rundu to Mbambi Roads D3448 and D3468 from the junction to Cuma along the new D3401 Road.
Plate 1.14: Southern section of the proposed 2D seismic survey Line NS-5 detailed location shown by a drone ground view to the south (Kawe) between Mbambi and the D3400 Road near Kawe.
Plate 1.15: Western section of the proposed 2D seismic survey Line EW-1 detailed location shown by a drone aerial view to the east along the new D3401 Road from Nuncuni to Cuma passing through the community forestry.
Plate 1.16: Middle section of the proposed 2D seismic survey Line EW-1 detailed location shown by a drone aerial view at Cuma towards the west along the new D3401 Road from Ncuncuni to Cuma passing through the community forestry.
Plate 1.17: Eastern section of the proposed 2D seismic survey Line EW-1 location shown by a drone aerial view to the east at cross cutting with NS-5 at the Rundu to Mbambi Roads D3448 and D3468 from the junction to Cuma along the new D3401 Road.
Plate 1.18: West section of the proposed 2D seismic survey Line EW-2 detailed location shown by a drone aerial view to the east along the D3400 and passing through the community forestry.
Plate 1.19: Western section of the proposed 2D seismic survey Line EW-2 location shown by a drone aerial view to the east from the D3400 junction to Taratara. This road is recommended as the alternative survey line for the EW-2 for the eastern section.
Plate 1.20: Eastern section of the proposed 2D seismic survey Line EW-2 detailed location shown by a drone aerial at view at Taratara looking towards west and along the recommended alternative survey line towards D3400 from Taratara.
Plate 1.21: Western section along D3400 Road of the proposed 2D seismic survey Line EW-3 detailed location shown by a drone aerial view to the south toward Ncaute along the D3400 Road.
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Plate 1.27: Middle section of the proposed 2D seismic survey Line EW-4 detailed location shown by a drone aerial view to the northeast within the middle of the community forestry. The EW-4 survey line run through an existing Community Forestry track to Hamoye along the D3400 Road from Rundu to Ncaute.
Plate 1.28: Eastern-section of the proposed 2D seismic survey Line EW-4 detailed location shown by a drone aerial view to the west through the community forestry near Hamoye along the D3400 Road from Rundu to Ncaute.
Plate 1.29: Western-section of the proposed 2D seismic survey Line EW-5 detailed location shown by a drone aerial view to the east along the existing track from the B8 junction to Gcaru through Sivaradi.
Plate 1.30: Western-section of the proposed 2D seismic survey Line EW-5 detailed location shown by a drone aerial view to the east along the existing track from the B8 junction to Gcaru through Sivaradi.
Plate 1.31: Eastern-section of the proposed 2D seismic survey Line EW-5 detailed location shown by a drone aerial view to the west along the existing track from Gcaru to Sivaradi.
Plate 5.32: Access track linking the D3425 to the B8 tarred Road from Grootfontein to Rundu passing north of Mangetti National Park is an alternative potential East-West seismic survey line if required. This specific track was inspected by the Ministry of Environment, Forestry and Tourism team during the field familiarisation / inspection visit undertaken on the 18th and 19th January 2021 to the project area.
1.5 Onshore Petroleum Exploration History

1.5.1 Overview of Onshore Petroleum Exploration History

Onshore oil and gas exploration in Namibia began with the drilling of the Berseba-1 well in the southern Nama Basin in 1928 by South West Africa Petroleum based on surface geology studies, which included the visibility of bitumen veins in outcrops, but was uncommercial (Miller, 1992). According to Miller, (1992), Oowambo (Etosha) Basin has been held under concession by Etosha Petroleum since 1959. The Owambo Basin in the north saw activity initiated in the early 1960s with a focus on early vintage potential fields data, including gravity and magnetic data, surface geology and outcrop mapping, soil gas geochemical sampling, augmented with limited 2D seismic acquisition and interpretation, and the drilling of four critical deeper wells (ReconAfrica, 2020).

1.5.2 History of Petroleum Exploration in Northern Onshore Namibia

The following is the summary history on oil and gas exploration activities covering aerial and ground geophysical survey (Aeromagnetic, gravity and seismic surveys) and well drilling operations in northern onshore Namibia inclusive of the newly discovered Kavango Basin by ReconAfrica (Figs. 1.6 – 1.8, Miller, 1992; Hoak, et. al., 2014 and ReconAfrica, 2020):

(i) Aeromagnetic, Gravity and Seismic Survey conducted in northern Namibia since 1962 (Figs. 1.6 – 1.18):

- 1962: Regional Aeromagnetic survey by Texas Eastern.
- 1963: Ground-based gravity survey by Ray Geophysical.
- 1990: 2D seismic by Overseas Petroleum Investment Corporation (OPIC).
- 1990: Aerogravity data by Overseas Petroleum Investment Corporation (OPIC).
- Since 1992: Namibian Government with support from the European Union and Germany Government has acquired high resolution magnetic and radiometric data over the whole, country as well as gravity, electromagnetic and hyperspectral data sets on selected areas.
- 2003: Aeromagnetic and gravity survey conducted by First African Oil (circle Oil).
- 2012: Aeromagnetic and gravity survey conducted by Preview Energy (Pty) Ltd (Permitting and technical support provided by Risk-Based Solutions).
- 2013: Aeromagnetic and aerogravity survey by Hydrocarb Energy, and.
- 2018: 2D seismic survey by Acrep Exploracao Petrolifera SA (Environmental permitting and monitoring support provided by Risk-Based Solutions).

(ii) Other petroleum exploration method conducted in northern Namibia since 1967:

- 1967: Regional surface geochemistry study by Etosha Petroleum.
× 2010: Apatite Fission Track Analysis (AFTA) from the Etosha Strat Test #1 and 5-1A wells study conducted by Preview Energy (Pty) Ltd (Permitting and technical support provided by Risk-Based Solutions).

× 2012: Field-based outcrops sampling for source and reservoir rocks by Preview Energy (Permitting and technical support provided by Risk-Based Solutions).

× 2012 and 2013: Field-based outcrops sampling for source and reservoir rocks by Hydrocarb Energy.

× 2012: Limited soil gas survey by Frontier Resources west of PEL 73 in PEL 72.

× 2015: ReconAfrica purchased additional high resolution aeromagnetic data covering the Licensed Property and conducted a detailed analysis of the resulting data and other available data related to the block, including reprocessing and reinterpretation of all existing geological and geophysical data. This led to the identification on the Licensed Property of the Kavango Basin, and.

× 2018: Geochemical soil sampling by Acrep Exploracao Petrolifera SA (Permitting and additional support provided by Risk-Based Solutions).

(iii) **Well drilling operations conducted in northern Namibia since 1964 (Fig. 1.6):**

× 1964: Stratigraphic Test #1 well (Total Depth1890 m) was drilled by Etosha Petroleum.

× 1970: Etosha 1-1 (Total Depth 1593 m) and 2-1 (Total Depth 1235 m) wellbores two shallow wells and one deeper test and the Etosha 5-1A (Total Depth 2523 m) deeper test were drilled by Etosha Petroleum, and.

× 2020: ReconAfrica proposed to drilled two (2) ï three (3) stratigraphic wells to confirm the presence of the newly discovered Kavango Basin.
Figure 1.6: Digital elevation model of Owambo (Etosha) Basin showing the historical magnetic/gravity survey boundaries, seismic grid, and well locations (Source: Hoak, et. al., 2014).
Figure 1.7: Overview of the existing geophysical Government data coverage over Namibia (Source: www.mme.gov.na).
Figure 1.8: Historical seismic survey in the general area showing the location of the recent, 2018, 2D seismic survey that was conducted by CGG using Vibroseis trucks on behalf of the license holder Acrep covering PEL 72 situated west of PEL 73. With the permitting and monitoring support by Risk-Based Solutions team, the ground seismic survey was conducted successfully with the participation of the local communities along the survey lines and witnessed in the field by the Hon. Governor of the Kavango West Region, Councillors, and traditional authorities. Similar field-based organisation arrangements will be adopted for the proposed 2D seismic survey in PEL 73 by ReconAfrica.
1.6 Structure of the Report

The following is the summary structure outline of this scoping report.

- **Section 1: Project Background** covering Introduction, project motivation, site description and detailed seismic survey line locations and history of oil and gas exploration onshore northern Namibia.

- **Section 2: Description of the Proposed Project** covering origin of oil and gas, understanding oil and gas exploration process, and detailed description of the proposed 2D seismic survey operations.

- **Section 3: Regulatory Framework providing** a summary of the applicable legislations and permitting requirements.

- **Section 4: Receiving Environment** covering physical environment (climate, water, air quality, and geology), Biological environment (flora, fauna and ecosystem services and functions) and socioeconomic environment.

- **Section 5: EIA and EMP Terms of Reference (ToR)** covering assessment procedure, alternatives considerations, likely positive and negative impacts, impact assessment and overall key summary of impacts associated the proposed 2D seismic survey operations, and.

- **Section 6: Scoping Conclusions and Recommendations** covering the key issues identified and summarised recommendations.
2. PROPOSED PROJECT SUMMARY

2.1 Origin of Petroleum and Petroleum Exploration

Petroleum (oil and gas) is formed from the remains of ancient marine organisms, such as plants, algae, and bacteria in geological environmental called Sedimentary Basins (Fig. 2.1). A Sedimentary Basin is a region of the Earth where long-term depressional setting has allowed for the accumulation of thick layers of sediments with remains of ancient marine organisms. As the sediments continue building-up and are buried deeper within a Sedimentary Basin, the various bottom layers that were initially deposited, will be subjected to increasing pressure and temperature because for every 1km that one goes deeper into the earth’s crust, the temperature on average increases by 25°C. The increase of temperature and pressure as a result of the weight of the overlying materials, initiates the process of cooking. If the sedimentary rock has enough organic materials for generating oil and gas and if the subsurface conditions are favourable, oil or gas may be generated within the temperature window range of between 100°C - 120°C and equivalent to the depths of more than 4km. The oil or gas that get deposited within the Sedimentary basin, again if the conditions and geological structures favours its accumulation, will remain trapped until discovered or until the natural conditions within the basin changes and forces the oil or gas to leak or vaporise. Such changes in Sedimentary basin conditions may be as a result of increasing temperature within the basins cooks the oil or gas forces it to vaporise or could also be the opening of the trap that allows the oil or gas to escape and leak out.

In simple terms a license area for oil and gas and a sedimentary basin are like a plot with a built modern family home comprising bedrooms, kitchen and dining and other rooms. A house, if built, often occupies a fraction of any given plot and is correspondingly to a Sedimentary Basin if present within a license area and only occupies a fraction of any given license. In oil and gas terms, the key areas of interest for the entire house (Sedimentary Basin) are the kitchen and dining room equated to a source and reservoir rocks respectively. Within a house environment, food is cooked in the kitchen and eaten in the dining room. Oil is formed in source rock (kitchen) and then it migrates and accumulates in a reservoir (dining room) which is often the key target area for any oil and gas exploration operations. A reservoir is similar to a dining room for anyone hoping to have a good meal, especially after noticing cooked food remains in the kitchen. However, even after noticing cooked food remains in the kitchen (sources rock), there is no guarantee that the food will still be in dining room because may be someone was already in dining room and has eaten all or much of the food and this is similar to the situation where oil or gas is formed and signs of it are detected in the source rock (kitchen) and a reservoir is found but it is empty or has some oil or gas but not economic.

The sedimentary rocks capable of generating oil or gas when subjected to high pressures and temperature are called source rocks e.g. limestone or shale. Once oil and gas resources are formed, they are flushed out of the source rock due the high pressure created by the weight of the overlying materials. Oil and / or gas often migrates to suitable area where accumulation takes places in rocks called oil or gas reservoirs. A petroleum reservoir or oil and gas reservoir is a porous or fractured subsurface rock mass saturated with hydrocarbons and can be a sandstone, shale, limestone or salt dome. Pores space and permeability are key important rock properties in oil and gas exploration. Pore space being the void space in the rocks, while permeability defines the connection of the pore spaces (pores) to each other which then allows fluids to flow in a rock. Most shales have very low permeability, but relatively good porosity ‘i reason for fracking to allow oil or gas to flow to hole if discovered in a shale rock.

Petroleum reservoirs are broadly classified as conventional (with natural pores and permeability) and unconventional (natural pores but limited permeability). It is important to know that fracking only comes into play after the discovery of economic vast oil or gas reserves found in a reservoir with natural storage (pores) but limited storage connectivity (permeability) abilities. At present Namibia does not have any onshore oil or gas discovery and yet alone in a reservoir with limited connectivity abilities and requiring fracking to produce or pump it.
Figure 2.1: Illustration on how oil and gas are formed over millions of years (Source: https://letslearngeology.wordpress.com/oil-formation-petroleo/).
2.2 Understanding Petroleum (Oil and Gas) Exploration

Oil and gas exploration is indeed an expensive journey with uncertain known destination and if one compares it to say a journey from Windhoek to Rundu, ReconAfrica has left Windhoek but has not yet even arrived in Okahandja and that is the reality. However, to fund the journey to the destination which is Rundu, ReconAfrica or any other resources exploration company must market a vision about the destination even though there are no guarantees that the destination will be indeed Rundu which could be equated to a commercial discovery at the end of an exploration / prospecting programme aimed at validating a developed theoretical oil or gas model.

When developing a theoretical model for oil or gas exploration, all the boundary conditions including the conventional and conventional options are usually included in the sub models’ assumptions and the objective of implementing the exploration programme is to de-risk the model by validating and testing the key input variables which were initially assumed for the knowledge-base and boundary conditions. Unfortunately, those with no knowledge of how this complicated and highly technical oil and gas exploration business operates, often tend to rush into populating the knowledge-base and drawing-up boundary conditions of the theoretical hydrocarbon model that they do not even know or understand.

Oil and gas exploration process starts with the implementation of developed theoretical hydrocarbon model over the entire licensed area to identify potential key targets of interest in form of a Sedimentary Basin with potential to host source rocks and reservoir structures with theoretically assumed boundary condition that support the occurrence of economic oil and gas reserves.

The following is a summary of general exploration de-risking activities that are implemented in validating the developed theoretical hydrocarbon model including boundary conditions for identifying site-specific localities with potential for holding economic oil and gas resources or uneconomic resources or nothing because exploration does not guarantee discovery and those undertaking and financing / investing in oil and gas exploration know very well the high stakes and rewards involved in this business:

1. Regional and local desktop study: This is the assessment of all existing data sets such as the geology, environment, hydrogeology, aerial, and ground geophysics (Gravity, Magnetics and Seismic), historical wells drilled in the region and general area. This data is normally purchased from the Government and in Namibia, Namcor sales this data in USD. The overall objective is to build a prospectivity sub model of the licensed area by identifying potential targets or initial leads within the license area. This step covers the whole licensed area and with limited to no fieldwork undertaken.

2. Based on the desktop studies above, usually detailed assessment of any existing geophysical data such as ground or aerial gravity, magnetics or ground seismic is undertaken, although gravity data is one of the key primary data sets. Gravity data is used to identify key areas of interest having thick sediment deposit or build-up (Sedimentary Basins) and such as areas are often coloured blue on gravity map.

3. Magnetic data will often be used to identify geological bodies that may have intruded the potential thick sediment areas (Sedimentary Basins) and if oil and gas was there at the time of the intrusion occurring, then the geological body may have cooked it and forced it to vaporise and disappear. Therefore, high magnetic zones will be no-go zones or not prospective for oil or gas exploration activities.

4. To understand if the identified sedimentary areas without potential magnetic geological bodies have potential geological structural traps called reservoirs that can store oil or gas, ground seismic survey is usually undertaken, followed by drilling of an exploration well/s to test and see if the seismic identified geological traps or reservoirs indeed exist and contain oil or gas and this EIA focuses specifically at this stage of the exploration process (2D seismic survey). However, in some instances the existing geological information can be insufficient to be able to plan and design an exploration well. In order to de-risk the exploration operations especially in a situation where the presence of a sedimentary basin...
is unknow, Stratigraphic Test Wells are sometimes drilled, similar to the two (2) to three (3) wells that ReconAfrica is proposing to drilled. A Stratigraphic Test Well is any well or hole, drilled for the purpose of gathering geological information (logging) in connection with the oil and gas exploration opportunities with no intent to produce oil or gas from such well.

5. If Stratigraphic Test Well drilling operations confirm the presence of a sedimentary basin, 2D or 3D Ground Seismic Surveys are often undertaken before any detailed exploration well/s drilling operation is implemented. Seismic survey works like an Ultrasound imaging also called ultrasound scanning or sonography using sound to generate images of the human body. Seismic surveys use an energy source to generate sound waves used in the imaging of the earth’s subsurface in search for potential reservoirs structures. These structures will thus be potential targets for exploration well/s drilling operations if the key boundary conditions are favourable.

6. Following the acquisition and processing of the 2D or (3D) seismic data and the delineation of potential geological structures, the drilling of exploration wells follows. An exploration well is drilled to find out if there is any oil or gas at a given locality. Exploration wells are drilled purely for exploratory and information gathering purposes and not for oil or gas production. Several exploration wells have been drilled in both the onshore and offshore environments of Namibia.

7. Once an exploration well has discovered oil and gas, the next step in the exploration process is to determine the economics of the find and the de-risking process cover the drilling of multiple appraisal testing wells in order to define the size of oil or gas field discovered. The overall aim is to assess the characteristics of the reservoir and determine if the discovered oil or gas can be produced economically using either conventional and unconventional production methods. However, the discovery of oil or gas does not guarantee a commercial discovery production and a good example is the Kudu Field discovered in 1974 by Chevron Texaco, offshore southern Namibia. The Kudu Gas is situated about 170 kilometres northwest of Oranjemund and in water depth of about 170m. Since its discovery, the field has been owned by several major global oil and gas exploration and production companies and despite being under a Production License, to date no development model has proved favourable to produce the gas from this field. Various production options such as the liquefying of the gas for export to Europe and building of a 170 km long pipeline to a power station that could have been built at Uubvlei, approximately 25 km north of Oranjemund in southern part of Namibia to generate clean electricity, have all failed the economic test, and.

8. The economic evaluation is very a complex process and will consider issues related to how the oil and gas could be produced safely and economically. Subject to the type and characteristics of the oil or gas discovered, considerations for the development of key supporting infrastructure such as a pipeline, a refinery or a power station option will be evaluated with linkages to the technological requirements, national environmental, security, financial and all other applicable national regulations and international standards for oil and gas production.

A holder of Exploration License can apply for a Production License through the MME with a new EIA being done in order to obtain a new ECC for conventional or unconventional oil or gas production operations.

Once all permits have been obtained, the development of the oil or gas field can then start and it takes years before a field can start to produce oil or gas and the country can start getting long-term tangible benefits from the production and direct or indirect sale of oil and gas produced. Usually, economic benefits from commercial oil and gas discovery starts earlier before the gas or oil field even start to produce.

During the development process massive capital inflow comes into the country and an array of employment opportunities are often created associated with field development activities and all the supporting infrastructure development process.
2.3 Proposed 2D Ground Seismic Survey as an Exploration Method

2.3.1 Basic Principles of 2D Ground Seismic Survey

Ground seismic survey method are among the proven technologies that are used in the search for earth resources. The results from the 2D ground seismic survey operations will assist in delineating potential target areas suitable for drilling of exploration wells. Land seismic data acquisition uses primarily two types of seismic energy sources, non-impulsive Vibroseis trucks and Explorer 860 or an impulsive energy source such as a low-impact charge that generate acoustic waves which propagate deep into the earth. During the seismic survey, the generated seismic wave which travels into the earth, reflected by subsurface formations, and returns to the surface where it is recorded by receivers called geophones which are like microphones (Fig. 2.2). The resultant product is a vertical sonic cross-section of the subsurface beneath the survey line showing the geological materials (de-risked geological sub model) and structures that the acoustic wave has travelled through (Fig. 2.3). This information is used to predict where oil or gas may be trapped in sufficient quantities for exploration activities.

![Image of 2D ground seismic survey operation](http://www.polarisexplorer.com)

Figure 2.2: Illustration of the 2D ground seismic survey operation to be undertaken in PEL No. 73 along the proposed lines using the Explorer 860 as the energy sources with wireless receivers (Photos Source: [http://www.polarisexplorer.com](http://www.polarisexplorer.com)).

2.3.2 Vibroseis, Dynamite or Explorer 860 Seismic Operations

2.3.2.1 The Use of Dynamite as an Energy Source

Since the beginning of seismic exploration, dynamite has been the universally acceptable source for generating seismic energy because it produces great quantities of energy. It is not expensive as vibroseis and it is equally safe to use only when handle correctly by experts. It can be used in both land and marine work in most climate and field conditions. Characteristic of seismic dynamite explosive developed for seismic work use nitroglycerin and / or nitrocellulose as active ingredients. This substance in its pure state is extremely dangerous and highly volatile. However, when these highly explosive substances are absorbed by a pores material such as wood pulp, kieselguhr, powdered chalk, or roasted flour they are quite safe to transport, to store and use (Monk et al., 2004).

The cost of drilling holes for a dynamite-based seismic survey can become a critical factor in the overall design of the survey. This effectively places a limit on the shot line interval, and the shot interval down
When using the surface weight drop system, shots can be taken very rapidly, and with more than one unit active it is possible to achieve levels of shot production which are likely to be much higher than achievable with dynamite. In this case the limiting factor to operational efficiency moves away from the shots, and recording is limited by the number of receivers that have to be moved on a regular basis. If receiver limits the operation moves, then the number of shots can be increased (with surface weight drop) without any increase in cost of operations. It is therefore possible to increase the effective fold of 2D seismic using surface weight drop systems by decreasing the shot interval along the shot line without detriment to the efficiency of crew, or cost of operation. This further has the potential to improve the quality of the final seismic data. The following are the key characteristics advantages and disadvantages of using dynamite as an energy source:

- Dynamite is a good energy but once it is gone it is gone since it is not renewable, and.

- One advantage of dynamite is the high-power source of short duration as such, it creates a compact wavelet with a wide bandwidth. Another advantage a dynamite has over vibroseis trucks are its light weight, low-cost lack of required maintenance and capacity for deployment in rugged terrain unreachable by vehicles (Oriard, 1994). However, the process of drilling shot holes, burying the dynamite, and cleaning up after the operation is labour intensive, and with this option the survey geometry cannot be changed without drilling new shot holes. Hence, input signal can be neither measured nor reliably repeated. Also, dynamite explosive sources are subject to strict security regulations and permission for use and transportation may be difficult to obtain in some places. The carry a greater potential for causing damage hence their prevention in usage in populated areas (Oriard, 2002).

2.3.2.2 The Use of Vibroseis as an Energy Source

The vibroseis method was developed in the USA to allow seismic to be acquired in cities and other sensitive environments, eliminating the need for dynamite to generate the much needed seismic signal, instead, generating a controlled vibration that will not damage structures in close proximity to the produce signal source (Teasdale et al., 2006). The following are the key characteristics advantages and disadvantages of using Vibroseis as an energy source:

- Vibroseis has a greater advantage in energy spectrum control as this can be done with much ease than in the use of dynamite. The force applied to the ground can be monitored and adjusted in real time. Hence the effective usage of vibroseis in urban areas. However, vibroseis have great restriction of access in difficult terrains like swamps, mountains and coastal areas (Oriard, 1999).

- One of the most important characteristics of Vibroseis method is the limitation of the bandwidth of the source. By this way, vibroseis technique allows one to generate only those frequencies which are needed whereas with the case of dynamite, some of the frequencies generated by the blast are ignored during the seismic acquisition, and.

- Explosive source develops its power in a very short time whereas vibrational sources distribute their power for a sustained period usually several seconds.

2.3.2.3 The Use of the Explorer 860 as an Energy Source

The new source Explorer 860 (Plate 2.1) has the capability of generating a very large surface impact, with a high degree of repeatability, but it also controllable so that the impact effort can be reduced if required. This control has help to minimized ground roll generation and improved the resultant seismic data. The only difference is that instead of hitting the ground with the plate a special aluminium alloy steel is put on the ground and transfers energy to the ground. All the weight is put on the plate and energy is transferred to a recorder. The hammer comes down on the plate leaving next to no imprint on the ground. The impact on the steel, steel on steel and energy is transferred. This method has significantly replaced the dynamite because energy is renewable in this form than in the dynamite system. The following are the key characteristics advantages and disadvantages of using the Explorer 860 as an energy source:
The Explorer 860 is the world fastest, strongest and most accurate accelerated weight drop seismic energy source. It is environmentally friendly and has worked in urban and protected areas with virtually zero ground disturbance.

Unlike conventional weight drop system, the Explorer 860 is also highly controllable. The system uses hydraulics to raise and lower the weight, and plumbed into the top of the hydraulic cylinder is a nitrogen gas charged accumulator. Pressure in the accumulator can be adjusted, and this pressure controls the force acting on the top of the weight when it is released.

- Has up to 860,000 lbs of peak force.
- Faster than the vibroseis.
- Has very high fold.
- Has better quality than dynamite.
- Is perfect for high density population and environmental sensitive areas.
- Has only single unit required per second source point, and.
- One disadvantage of Explorer 860 is its capital deployment to site of interest and maintenance.

Plate 2.1: Size comparative of the Vibroseis truck (top) and Explorer 860 Accelerated Weight Drop (AWD) (bottom) (Sources: www.polarisexplorer.com).
2.3.3 Proposed 2D Seismic Survey Design, Layout and Implementation

2.3.3.1 Proposed Survey Design and Layout

The location of the proposed 2D seismic survey lines numbered NS1-NS5 and EW1-EW5 are shown in Fig. 1.4. The proposed survey lines will follow existing roads and tracks as shown in Figs. 1.4 and 1.5 and Plates 1.1 -1.32. The technical design and layout of the proposed 2D seismic survey covers the following key considerations:

(i) North-south and east west oriented lines have been designed with line layout cutting across the key areas of interest as shown in Fig. 1.4.

(ii) All the lines have been designed to follow existing roads or tracks that have been verified to exist as sown in Fig. 1.5.

(iii) All the roads and tracks along which the survey will be conducted have been verified to exist as shown in drone views in Plates 1.1 -1.32.

2.3.3.2 Proposed 2D Ground Survey Implementation Stages

The implementation of the proposed 2D ground survey programme can be divided into three (3) stages and each stage evaluated in detailed during the EIA stage. The following is the summary of the four (4) stages:

(i) Pre-survey scouting to assess accessibility and confirm the line survey scouting to be included in the EIA Process.

(ii) Planning and mobilisation (Tracks / roads preparation (Clearing and widening).

(iii) Data acquisition (Actual Survey), and

(iv) Demobilisation and survey completion.

The Survey Team will mobilise and will consist of one (1) Survey Coordinator, one (1) Survey Processor/Mapper, 2 National field mappers and 6 National survey rovers. Survey teams will be expected to survey between 150-250 points per day with a total daily production of 1600 source points per day = 95 km per day. Each Survey Rover will have two (2) local helpers - who will be trained in survey techniques.

The Survey Team will immediately set up a control network and once established will begin surveying. Line surveying will be conducted utilising Trimble R8 RTK GPS receivers. The Survey Coordinator, along with the Project Manager and Security Manager will have a daily plan for the Survey Team. Daily production for each team will be 3-4 km per day.

Positions will be marked with which marker is most effective and least likely to be disturbed by the local villagers. These could be pin flags, lathe, shipping tags, ribbon or painted rocks.

A dedicated Survey Processor will be on site throughout the duration of the project to manage Survey data; update and organize information passed along; and maintain a hazard map for quick reference by all crews to understand recognized hazards. The Survey Processor will be responsible for delivering survey data to the on site quality control Geophysicist whose responsibility will be to deliver script files to the Observer for recording.

All positional surveying work will be carried out to a good professional standard and all personnel engaged in geodetic, surveying, positioning and setting out work will be appropriately qualified and experienced and be fully aware of the objectives, methods to be employed and accuracy required.

Modern survey equipment and techniques will be employed. Survey control will be Established using no less than 4-hour static survey preferably with 2 other baselines running concurrent or Bases
checked with 180 epoch RTK shot. All static survey control will be processed with the Canadian Government Internationally accepted processing utility. Check shots for each roving GPS pack will be made at the start and end of every day and checked in database.

Co-ordinates will be based on the geodetic framework as specified by ReconAfrica. Survey observations of all control and line points will contain redundancy for checking purposes and be observed and recorded in such a way as to allow independent verification of plan and height values.

All surveying methods will be checked, all equipment calibrated and results of software in use verified to the satisfaction of ReconAfrica prior to commencement.

Lateral offsets will be indicated on all documents (topographic reports, line logs, etc.). In the presence of obstacles, culture or cultivated areas, with prior ReconAfrica Representative agreement, the obstacle will be either laterally offset or undershot, according to the size of the obstruction.

When determining source locations, the contractor will observe ReconAfrica and local procedures and/or regulations governing minimum shooting distances from structures such as buildings, roads, pipelines, etc. Peak Particle Velocity (PPV) measurements will be made by the contractor at the start and during the seismic survey to confirm the above.

Go-arounds will be marked by the surveying teams in the field and annotated on the line logs. Mapping ahead of the survey crew to identify hazards, obstacles and culture will be done to ensure safety, create a hazard map and virtually remodel line and shot point locations.

Pre-plot co-ordinates for source points (VPs/SPs) and receiver points (RPs) will be generated by the contractor and submitted to ReconAfrica for approval prior to start-up.

2.3.4 Description of Proposed Data Acquisition Process

The data acquisition process for the proposed 2D seismic survey operations will be undertaken as illustrated in Fig. 2.2. The proposed 2D seismic survey will be undertaken using two (2) to three (3) Explorer 860 Accelerated Weight Drop (AWD) energy source instead of Vibriosis trucks or dynamite. The Explorer 860 AWD provides unrivalled force and production. Polaris Seismic’s patented Explorer 860 uses servo-valve and mass Low Vibration Track (LVT) technology to produce the most powerful, repeatable, and productive surface energy source in the World. Table 2.1 shows the parameters design options for the proposed 2D seismic survey in PEL 73.

Key specifications of the Explorer 860 to be used as the energy source for proposed 2D seismic survey operations in PEL 73 are shown in Fig. 2.3.

Table 2.1: Proposed 2D seismic survey parameters design options.

<table>
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<th>Option 1</th>
<th>Option 2</th>
<th>Option 3</th>
</tr>
</thead>
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<td>Number of Receivers</td>
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<td>17,500</td>
</tr>
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<td>Node</td>
<td>Node</td>
</tr>
<tr>
<td>Geometry</td>
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<td>7990-10-X-10-7990</td>
<td>9990-10-X-10-9990</td>
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</tr>
<tr>
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<td>6 sec</td>
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<tr>
<td>Total Kilometers</td>
<td>350-450</td>
<td>350-450</td>
<td>350-450</td>
</tr>
</tbody>
</table>
Figure 2.3: Specifications of the Explorer 860 to be used as the energy source for proposed 2D seismic survey operations in PEL 73 (Source: www.polarisexplorer.com).
2.3.5 Recording / Geophones

Energy source points and receiver points will be placed along each of the survey lines targeted to be surveyed. The receiver points whose main purposes will be to record the reflected vibrations from Vibroseis. The spacing of the source and receiver points is determined by the design and objectives of the survey and for the proposed 2D survey. Wireless geophones / receivers / recorders will be used in the proposed survey (Plate 2.2).

The proposed survey will use the STRYDE recording technology which represents the latest, smallest, and most easily deployed system on the market with the following specifications (Plate 2.2):

- 28 days recording at -40 C with 24 hours recording.
- Global Navigation Satellite System (GNSS) enabled with precision timing and self-location capability.
- Compact with a weight of 150 gm and dimensions: 129 x 41 mm.
- One person can carry 90 nodes.
- Rapid turn-around with a 4-hour concurrent data download and charging.
- A 20ft container allows re-charge and download of ~20,000 nodes per day.
- Rugged Sealed Construction and No connector points, and.
- Inductive charging, optical data transfer with a Sealed casing.

Deployment with the STRYDE system is very fast. The proposed acquisition plan includes:

- 2,000 nodes available (or more as may be required for higher density options).
- Three (3) Layout crews with 3 men per crew.
- Two (2) Pick-up crews with 2 men per crew.
- Layout of 1000+ Nodes per day.
- Pick-up of 1000+ Nodes per day, and.
- Concurrent harvesting and charging of 900 Nodes per day.
Plate 2.2: The STRYDE wireless recording instrumentation is the latest technology to be used for the proposed 2D seismic survey operations.

### 2.3.6 Data Processing and Interpretation

A Seismic Quality Control Field Processor and required onsite data processing will be onsite for the entire duration of the proposed 2D seismic survey operations (Plate 2.3). Field Processing will be completed daily with the requested processing flows outlined in the Scope of Work. Processing software includes the current Vista Field Pro software system. All supporting equipment and services will be available including plotters, monitors, etc. STRYDE systems do not process data but output raw gathers / receiver data subject to 125hz high cut filter. Very-small-aperture terminal (VSAT) communications will allow transmission of data to processing centres as required by ReconAfrica.

The data recorded from the seismic survey will be raw or in unprocessed form. Before it can be used, it must go through a series of computerised processes. These processes such as filtering, stacking, migrating and other computer analysis, make the data useable and require powerful computers and sophisticated computer programs. As computers have become more powerful and processing techniques more sophisticated, it has become common to re-process seismic data acquired in earlier years, creating new opportunities for exploration that could not originally be derived from the 2D data. Processing of data can be very expensive and time-consuming, depending on the size of the area surveyed and the amount of data acquire.
Final resulting processed data will be interpreted by the geophysicist or geologist. The collected seismic data will be interpreted and no two experts will interpret data identically. Geology is still a subjective science. Although dry holes have been greatly reduced by seismic technology, they have not been eliminated. The proper interpretation of seismic survey data is a critical step in the process of selecting a suitable location for drilling of an exploration oil and gas well.

Plate 2.3: Example of the conaterised field-based data processing facility and supporting services that will be available for the entire duration of the proposed 2D seismic survey operations (Source: www.polarisexplorer.com).

2.4 Logistics and Resources

2.4.1 Overview

The proposed 2D seismic survey is likely to be completed within three (3) months from the date of implementation. The exploration team will comprise a number of specialists such geophysicist, geologists, surveyors, engineers as well as other supporting crew members such as exploration camp management, vehicles maintenance as well as catering teams. It is estimated that a total of up to forty (40) persons are likely to be involved in the proposed 2D ground seismic survey data acquisition process.

2.4.2 Fly Camp Site

A temporary survey campsite will be created within each survey block area. The temporary camp sites will be setup at suitable locations within the survey area and at strategic line intersections. The size of the exploration camp will be of very limited footprints and will be in form of containerised self-contained cabins. The following are some of the key considerations for selecting camp site areas:

× The creation of a camp site shall be undertaken with the permission of the traditional authority and the local headmen and owner of the land.

× The camp site shall not be created too close to the local settlements in order not to have too much interaction with the local community.

× No big trees shall cut around the selected camp areas.

× The camp sites shall be selected in abandoned previous cleared fields in order not to disturbed pristine areas.
The camp site shall be equipped with all the facilities and services including water supply and chemical toilets.

The EIA has assessed the likely impacts that the camp site may have on the receiving environment and mitigation measures are provided in the EMP Report.

2.4.3 Lines Widening / Clearing

The proposed survey will be undertaken along the already existing roads and tracks. A typical survey track will need a space opening along the survey line (track) of about three meters (3 m) wide. Wherever possible line clearance will take advantage of existing access that will allow close placement of receivers and source points to the pre-plot designated locations.

Following ReconAfrica’s guidelines for offsetting source points priority will be to minimise bush cutting and offset points to clear locations. In the case of Receiver points also meander the line to positions that require minimal line clearing. Layout crews will be equipped with pangas if line clearing is needed.

This is a benefit for all stakeholders because the approach will lessen any likely the impact or damage to the receiving environment. However, if requested by the local community / stakeholders to clear and widen any given track that will be used during the survey operations, this will be undertaken within the framework of Corporate Social Responsibility (CSR).

Supervision of line clearance equipment operators will be managed by the Survey Coordinator and assisted by a Surveyor experienced in the operation of GPS/ LIS (Low Impact Seismic) methodology.

2.5 Vibration, Noise and Dust

2.5.1 Variations

Ground motion caused by the vibration from seismic survey is generally barely perceivable. The further away you are from the vibrating source, the less you would feel the vibration (Teasdale et al, 2006). According to Teasdale et al, (2006), common household activities such as hammering a nail into a wall would cause more vibration to a house than a typical larger vibroseis truck operating in the area.

2.5.2 Noise and Dust

The following are possible sources of air and dust pollution that have been evaluated in the EIA Report with mitigation measures provided in the EMP Report:

(i) Sources of noise and air quality influences:

- Increased vehicle activities during survey operations along the gravel and tracks, and.
- Campsite activities including burning of fuels by vehicles and generators.

2.6 Health, Safety and Environment

2.6.1 Operational Manuals and Policies

The Contractor will prepare a comprehensive Health, Safety and Environment (HSE) operational standards, manuals, and policies for approval by the ReconAfrica. The HSE framework will link directly to the EMP framework covering bridging documents, HSE Management manual, project HSE plan, Waste Management Plan, Journey Management Plan, Grievance Mechanism, and Cultural Heritage Procedure.
3. LEGISLATIVE FRAMEWORK

3.1 Overview

The statutes, common, customary, and international laws are the four (4) sources of laws as enshrined in the constitution which is the supreme law of Namibia. All other laws must be in line with the Namibian Constitution. The most important legislative instruments and associated authorisations, permits, licenses, concerts, compliances applicable to the proposed petroleum exploration activities (2D Seismic Survey) include: Petroleum, environmental management, land rights, water, atmospheric pollution prevention, health, and labour as well as other indirect laws linked to the accessory services associated with the proposed exploration technique (2D seismic Survey).

3.2 Key Applicable Legislation

3.2.1 Petroleum (Exploration and Production) Legislation

The national legislation governing petroleum operations in Namibia falls within the authority of the Ministry of Mines and Energy (MME) as the Competent Authority (CA) responsible for granting authorisations, permits, licenses, concerts, compliances as may be applicable to a petroleum exploration project. The legislative framework governing upstream oil and gas operations in Namibia is modern and well developed, and has been specially formulated for the international oil industry covering the following:


The Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991) is administered by the Petroleum Commissioner in the Ministry of Mines and Energy (MME) which is the Competent Authority. Under the Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991) the following Petroleum Upstream Licences may be granted to any applicant who may meet the requirements to be granted such a license:

(i) Petroleum Reconnaissance Licence (PRL): A reconnaissance licence allows its holder to carry on reconnaissance operations subject to terms and conditions as stipulated under Section 22-28 of the Act. A reconnaissance Licence is non-exclusive.

(ii) Petroleum Exploration Licence (PEL): An exploration licence allows its holder to carry on exploration operations exclusively in the block(s) to which it relates subject to the terms and conditions as may be specified in such Licence as stipulated under Section 29-38 of the Act.

(iii) Petroleum Production Licence (PPL): A production licence allows its holder to exclusively carry-on production operations on the block(s) to which that licence relates and to sell or dispose of petroleum recovered within such block(s) and any other activities as stipulated under subsections 39-43 of the Act. Only one (1) production License has so far been issued in Namibia covering the Kudu Gas field situated offshore in the Orange Basin near the border between Namibia and South Africa.


extension of the duration of exploration licences; to further regulate the obligation of holders of exploration licences in terms of the terms and conditions of any such licences; to rectify the provisions of section 41 in relation to discoveries which are of commercial interest; to provide for the submission of decommissioning plans together with applications for production licences; to make different provision for the royalty payable on petroleum in respect of licences issued after the commencement of this Act; to further regulate the annual charges payable by holders of exploration and production licences; and to provide for the decommissioning of facilities on the cessation of production operations; to amend the Petroleum Taxation Act, 1991 (Act 3 of 1991), so as to reduce the rate of petroleum income tax; to provide for the allowance of deductions in respect of annual contributions to trust funds established for purposes of decommissioning of facilities in certain areas; to levy tax on surplus amounts in such trust funds; to provide for the allowance of deductions in respect of exploration expenditure incurred in any one or more other licence areas where no gross income was received; to make other provision for additional profits tax payable by the holders of production licences issued after a certain date; and to make further provision for the modification of Part III by virtue of terms and conditions contained in a petroleum agreement in relation to participation by the National Petroleum Corporation of Namibia (Namcor) in exploration or production operations; and to provide for incidental matters.

3.2.2 Processing of Applying for a PEL and the Petroleum Agreement (PA)

In the absence of an auctioning licensing regime process, any individual or entity can submit an application for a Reconnaissance or Exploration Licences to the Ministry of Mines and Energy (MME) and such an application for a license may be granted subjected to the terms and conditions as stipulated in the Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991). The first step before an application can even be prepared and submitted to the Ministry of Mines and Energy, an applicant will need to develop a clear regional and local theoretical hydrocarbon model centred on a fully or partially known or assumed knowledge-base with key boundary conditions that must be tested and validated during the exploration process of building the knowledge-base. An application is often prepared by a technical team comprising Geological/ Petroleum Consultants with full technical and financial knowledge about petroleum exploration operations, regional and local geology and possible petroleum systems in Namibia.

An application will usually detail the proposed theoretical hydrocarbon model with key boundary conditions and provides a detailed process by which the proposed theoretical hydrocarbon model is going to be validated and this process is called exploration programme with detailed budget breakdowns. The cost for preparing such an application by the Consultants can be as high as USD10, 000.00 or more and this cost excludes technical data sets that must be purchased from the Government and sold in USD. Depending on the size of the license area, existing data set costs can be as high as USD50, 000.00. There is zero guarantee of recovering the cost of preparing the application and chance of the application being granted once submitted to the Government. Following the lodgement of such an application to the Ministry of Mines and Energy, and the payment of the non-refundable fee of N$30, 000.00 per application, a standard Model Petroleum Agreement (MPA) is given to the applicant if the application has been formally accepted by the Government (Ministry of Mines and Energy). The MPA is usually reviewed by the technical, financial and legal teams from both the applicant and the Government of Namibia.

Once a date for negotiating the Petroleum Agreement (PA) has been agreed, the technical, financial and legal teams from the applicant and the Government of Namibia meet to negotiate the terms and conditions of the PA covering exploration and possible production conditions in an event of a commercial discovery. The applicant will be required to lodge a guarantee against any non-performance related to the committed exploration activities and expenditure with respect to the committed exploration activities and expenditures. The exploration activities and expenditures guarantee are usually in the range of 10% of the exploration budget. Under Section 13 of the Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991), the Minister of Mines and Energy is required to enter into a Petroleum Agreement with an applicant for a petroleum exploration license before he/she grants such license. Once the Petroleum Agreement has been agreed and license annual fees charged between N$60.00 to N$150 per square kilometre which is about N$650, 000.00 for an average Degree Square Block as well as a mandatory annual contribution of around N$1.2 million to the Petroleum Training and Education Fund (PetroFund) are paid, a Petroleum Exploration
License is granted to the applicant by the Minister of Mines and Energy in accordance with the provisions of the Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991) and the PA. Finally, a Joint Operating Agreement (JOA) with NAMCOR (State Owned Company) or any other joint venture partner/s participating in the license is negotiated and the proposed exploration activities aimed at testing and validating the developed theoretical hydrocarbon model can now be implemented and monitored by the Ministry of Mines and Energy with annual reporting through a Technical Advisory Committee (TAC).

PetroFund was formed in 1993 in order to offer training in fields of science and information technology through scholarships and support education institution building (www.petrofund.org). The PetroFund provides bursaries and scholarships supports to a total of seventy (70) students every year to study Engineering, Geology, Education (Math and Science), Economics, Law and Computer Science at local, regional and international universities. This is made possible because of the contributions being made by oil and gas exploration companies that continue to undertake petroleum exploration activities in Namibia. The PetroFund is one of the vital and well-funded national financial support systems which is now being threatened by opportunistic Environmental Messiahs trying to champion unfounded ecosystem destruction with no knowledge on how the whole local, regional and global petroleum licensing, exploration, production operations, capital and operational global markets fund raising business actually operates and is benefiting disadvantaged Namibians who do not have the clique, class, ideology, privileges and patronage prevalent in some of the so called environmental non-profits outfits and movements

3.2.3 Key ImportantClauses of a Petroleum Agreement

3.2.3.1 Overview

The Petroleum Agreement gives a holder of PEL a right to the grant of an initial exploration license for a period not to exceed four (4) years (www.mme.gov.na). This may be renewed for further periods not exceeding two (2) years on each occasion. In general, a PEL may be renewed only twice. The Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991) empowers the Minister of Mines and Energy to extend the initial exploration period and the renewal periods by up to 12 months each in response to any operational exigencies of particular licensees.

The Petroleum Agreement makes provision for the PEL holder to commit to a minimum exploration work program as stated in the initial application. The Government often negotiates specially tailored exploration work programs for each PEL as may be applicable. The Petroleum Agreement also provides for the second and third tier rates of the Additional Profits Tax and the Training and Education Fee and the negotiated figures on these items are provided into the relevant clauses in the Petroleum Agreement. The Petroleum Agreement sets out the procedure to be followed by a licensee on discovery of petroleum. The licensee is forthwith to inform the Commissioner for Petroleum Affairs and then to evaluate the discovery to determine whether it is of potential commercial interest. If it is, the licensee has to take steps to appraise the discovery in accordance with an appraisal program in conformance with the requirements of the Petroleum Agreement. In an event of a commercial discovery expected that implementation of the appraisal program should be completed within two years although upon good cause shown to the Commissioner, he may extend the period.

The holder of a PEL who makes a commercial discovery is entitled to apply for a production license and, subject to complying with the requirements of the petroleum and other applicable legislations, is entitled to the grant of such license. A production license may be granted for a period not exceeding 25 years and may be renewed for such further period, not exceeding 10 years, as the Minister of Mines and Energy may determine at the time of such renewal request. A production license may be renewed only once. Among the many other clauses of the Petroleum Agreement is one that provides for a Technical Advisory Committee (TAC) consisting of an equal number of Government nominees and nominees of the licensee to monitor the petroleum operations of the licensee. The TACs under the First and Second Round Licenses proved to be a useful interactive forum between the Government and existing PEL holders in Namibia on the details of their petroleum operations.
3.2.3.2 Petroleum Agreement Environmental Protection Clause 11

Oil and gas exploration and production regulatory framework in Namibia provides for strict contractual obligations by a holder of PEL with respect to environmental performances as provided for in the Petroleum Model Agreement under the Environmental Protection Clause 11. The following is the extract from the Model Agreement, 2007, Environmental Protection Clause 11 which may be slightly different to the actual wording used in the onshore Petroleum Agreement for ReconAfrica but provides the general framework and obligations applicable for all PEL holders in Namibia:

11.1 The Minister and the Company concede that Petroleum Operations will cause some impact on the environment in the Licence Area.

11.2 The Company shall-

(a) conduct its Petroleum Operations in a manner likely to conserve the natural resources of Namibia and protect the environment.

(b) employ the best available techniques in accordance with Good Oilfield Practices for the prevention of Environmental Damage to which its Petroleum Operations might contribute and for the minimization of the effect of such operations on adjoining or neighbouring Lands, and.

(c) implement the proposals contained in its Development Plan regarding the prevention of pollution, the treatment of wastes, the safeguarding of natural resources and the progressive reclamation and rehabilitation of Lands disturbed by Petroleum Operations.

11.3 The Company undertakes for purposes of this Agreement to take all reasonable, necessary, and adequate steps in accordance with Good Oilfield Practices to minimize Environmental Damage to the Licence Area and adjoining or neighbouring Lands.

11.4 If the Company fails to comply with the terms of clause 11.3 or contravenes any law on the prevention of Environmental Damage and such failure or contravention results in any Environmental Damage, the Company shall take all necessary and reasonable measures to remedy such failure or contravention and the effects thereof.

11.5 If the Minister has reason to believe that any works or installations erected by the Company or any operations carried out by the Company are endangering or may endanger persons or any property of any other person or is causing pollution or is harming wildlife or the environment to a degree which the Minister deems unacceptable, the Minister may require the Company to take reasonable remedial measures within such reasonable period as may be determined by the Minister and to take reasonable and appropriate steps to repair any damage to the environment. If the Minister deems it necessary, he may require the Company to discontinue Petroleum Operations in whole or in part until the Company has taken such remedial measures or has repaired any damage.

11.6 The measures and methods to be used by the Company for purposes of complying with the terms of clause 11.3 shall be determined in timely consultation with the Minister upon the commencement of Petroleum Operations or whenever there is a significant change in the scope or method of carrying out Petroleum Operations, and the Company shall take into account the international standards applicable in similar circumstances and the relevant environmental impact assessment studies carried out in accordance with clause

11.7. The Company shall notify the Minister in writing of the nature of the measures and methods finally determined by the Company and shall cause such measures and methods to be reviewed from time to time in view of prevailing circumstances.
11.7 The Company shall cause a person or persons, approved by the Minister on account of their special knowledge of environmental matters, to carry out two environmental impact assessment studies, in order to determine the prevailing situation relating to the environment, human beings, wildlife or marine life in the Licence Area and in the adjoining or neighbouring areas at the time of the studies; and (b) to establish what the effect will be on the environment, human beings, wildlife in the Licence Area in consequence of the Petroleum Operations to be made under this Agreement, and to submit for consideration by the Parties measures and methods contemplated in clause 11.6 for minimising Environmental Damage and carrying out Site Restoration in the Licence Area.

11.8 The first of the two studies referred to in clause 11.7 shall be carried out in two parts. The first part of the first study shall be a baseline study of existing information on the environment, human beings, wildlife in the Licence Area. The company shall conclude such baseline study prior to undertaking any fieldwork for a seismographic survey. The second part of the first study shall be an environmental impact assessment study of the effects of drilling on the environment. This environmental impact assessment study is to be concluded sufficiently in advance of the commencement of drilling to enable the results of this environmental impact assessment study to be considered in preparing all relevant drilling management, waste management and contingency plans relating to the exploration drilling stage.

11.9 The second of the two studies referred to in clause 11.7 shall be an environmental impact assessment study of the effects of production on the environment and shall be concluded sufficiently in advance of the commencement of Production Operations to enable the results of this environmental impact assessment study to be taken into account in preparing all relevant production management, waste management and contingency plans relating to Production Operations and shall be submitted by the Company as part of its Development Plan.

11.10 The studies mentioned in clause 11.7 shall contain proposed environmental guidelines to be followed to minimise Environmental Damage and shall include, but not be limited to-

(a) Access cutting.

(b) Clearing and timber salvage.

(c) Wildlife and habitat protection.

(d) Resource protection.

(e) Fuel storage and handling.

(f) Use of explosives.

(g) Camps and staging areas.

(h) Liquid and solid waste disposal.

(i) Cultural and archaeological sites.

(j) Selection of drilling sites.

(k) Terrain stabilisation.

(l) Protection of freshwater horizons.
(m) Blowout prevention plan.
(n) Combating oil spills.
(o) Flaring during completion and testing of gas and oil wells.
(p) Well abandonment.
(q) Rig dismantling and site completion.
(r) Reclamation for abandonment, and
(s) noise control.

11.11 The Company shall ensure-

(a) that Petroleum Operations are carried out in an environmentally acceptable and safe manner consistent with Good Oilfield Practices and that such operations are properly monitored.

(b) that the pertinent completed environmental impact assessment studies are made available to its employees and to its contractors to develop adequate and proper awareness of the measures and methods of environmental protection to be used in carrying out its Petroleum Operations, and.

(c) that any agreement entered between the Company and its contractors relating to its Petroleum Operations shall include the terms set out in this Agreement and any established measures and methods for the implementation of the Company's obligations in relation to the environment under this Agreement.

11.12 The Company shall, before carrying out any drilling, prepare and submit for review by the Minister an oil spill and fire contingency plan designed to achieve rapid and effective emergency response in the event of an oil spill or fire.

11.13 In the event of-

(a) an emergency or accident arising from Petroleum Operations affecting the environment, the Company shall forthwith notify the Minister accordingly.

(b) any fire or oil spill, the Company shall promptly implement the relevant contingency plan.

(c) any other emergency or accident arising from the Petroleum Operations affecting the environment, the Company shall take such action as may be prudent and necessary in accordance with Good Oilfield Practices in such circumstances.

11.14 If the Company fails to comply with any terms contained in clause 11 within a period determined by the Minister under any such term, the Minister may, after giving the Company reasonable notice, take any action which may be necessary to ensure compliance with such term, and recover, immediately after having taken such action, all expenditure incurred in connection with such action from the Company together with such interest as may be determined in accordance with paragraph 6.2 of Annexure 4 to this Agreement.

11.15 If the Company or the operator for the Company has already completed and submitted to the Government reports on the studies referred to in clause 11.8 for a previous
Exploration Licence held in Namibia in the 5-year period preceding the application for this Exploration Licence and those studies either

(a) are sufficiently broad ranging to encompass clearly the present Licence Area, or

(b) do not encompass the present Licence Area but a baseline study and environmental impact assessment study have been submitted by the holder of an Exploration Licence covering an area near the present Licence Area the Company may in a case falling within (a) above, submit the reports on the studies for such previous Licence in fulfilment of the requirements of clauses 11.7 and 11.8 relating to exploration drilling and, in a case falling within (b) above submit such environmental impact assessment submitted by the said holder of an Exploration Licence, with any modifications which the Company wishes to make provided that:

(i) In response to a written request from the Company, the Minister approves in writing the course of action selected from (a) or (b) above.

(ii) In response to a written request from the Company directed through the Ministry of Mines and Energy, the Ministry of Environment, Tourism and Forestry, the Ministry of Works, Transport and Communication and the Ministry of Health and Social Services also approve in writing the course of action selected from (a) or (b) above.

(iii) The company that carried out the baseline study and environmental impact assessment study which are to be submitted in terms of (b) above agrees to this course of action.

(iv) The baseline study and the environmental impact assessment study submitted in terms of (b) above encompass the present Licence Area.

(v) Fluids, muds and chemicals to be used during drilling are the same as those used in the Exploration Licence covered by the environmental impact assessment study submitted.

(vi) Any other special studies relevant to an environmental impact assessment of the effect of drilling on the environment in the present Licence Area as may be required by the Minister are carried out and the results thereof together with plans for mitigating actions be submitted in the form of reports to the Government. A minimum of 12 copies of these reports are to be submitted.

(vii) The results of the resubmitted environmental impact assessment study as well as the studies conducted under (v) above are taken into account in preparing all relevant drilling management, waste management and contingency plans relating to the exploration drilling stage.

(viii) An amount equal to half the average cost of the three most recent baseline and environmental impact assessment studies complying with the requirements of the first of the studies in clause 11.7 for offshore oil exploration in Namibia or such other amount as may be agreed between the Parties is paid to the National Petroleum Corporation of Namibia (NAMCOR). This money shall be used by NAMCOR in accordance with the principles laid out in Annexure 7 in order to collect offshore environmental data relevant to oil exploration and production in Namibia. Projects to be undertaken by NAMCOR in this connection shall be decided upon in consultation with the oil exploration companies operating in Namibia and with the Ministry of Environment, Tourism and Forestry.
11.16 The Company shall on the expiration or termination of this Agreement or on relinquishment of part of the Licence Area-

(a) subject to clause 17, remove or otherwise deal with, as directed by the Minister in consultation with the Minister or Ministers responsible for environment, fisheries and finance, all equipment and installations from such Licence Area or relinquished area to the extent and in the manner agreed with the Minister in terms of the Decommissioning Plan approved by the Minister pursuant to s.68A(2) of the Petroleum Act.

(b) subject to clause 17, remove, or otherwise deal with, as directed by the Minister in consultation with the Minister or Ministers responsible for environment, fisheries and finance, all installations, equipment, pipelines, and other facilities erected or used outside the Licence Area for the petroleum operations. and

(c) perform all necessary Site Restoration activities in accordance with Good Oilfield Practices and shall take all other action necessary to prevent hazards to human life or to the property of others or the environment.

11.17 The Company shall on the date referred to in s.68B(1) of the Petroleum Act establish a Trust Fund in accordance with the provisions of s.68(B) of the said Act for the purpose of decommissioning facilities on cessation of production operations.

3.3 Other Key Applicable Legislation

3.3.1 Environmental Management Legislation

The Environmental Assessment (EA) process in Namibia is governed by the Environmental Impact Assessment (EIA) Regulations No. 30 of 2012 gazetted under the Environmental Management Act, (EMA), 2007, (Act No. 7 of 2007) in the Ministry of Environment, Forestry and Tourism (MEFT). The objectives of the Act and the Regulations are, among others, to promote the sustainable management of the environment and the use of natural resources to provide for a process of assessment and control of activities which may have significant effects on the environment. The Minister of Environment, Forestry and Tourism (is authorised to list activities which may only be undertaken if an environmental clearance certificate has been issued by the environmental commissioner, which activities include those relating to oil and gas exploration and production operations.

The proposed 2D seismic survey operations in PEL 73 area of interest falls within the categories of listed activities that cannot be undertaken without an Environmental Clearance Certificate (ECC). The current ECC granted in August 2019 allows the Proponent to continue with oil and gas exploration activities focused on the drilling of stratigraphic wells only. All the other subsequent exploration activities listed in the EIA Regulations and as may also be provided for in the

In addition to the requirements for undertaking Environmental Assessment prior to the project implementation, the Environmental Management Act and the EIA Regulations also provide for obligations of the PEL holder to provide for project rehabilitation and closure plan. In the regulations, the definition of rehabilitation and closure plan is a plan which describes the process of rehabilitation of an activity at any stage of that activity up to and including closure stage.

3.3.2 Communal Land Rights

The proposed 2D seismic survey operations cover the communal land of Kavango West and East regions administered by various traditional authorities through Regional Communal Land Boards. Communal land is land that belongs to the State and is held in trust for the benefit of the traditional communities living in those areas. Communal land cannot be bought or sold, but you can be given a customary land right or right of leasehold to a part of communal land in accordance with the provisions of the Communal Land Reform, 2002, (Act No. 5 of 2002). The Communal Land Reform, 2002, (Act No. 5 of 2002) provide for the allocation of rights in respect of communal land. to establish Communal
Land Boards. to provide for the powers of Chiefs and Traditional Authorities and boards in relation to communal land and to make provision for incidental matters. However, communal land is still owned by the State with the allocation of user rights delegated to the traditional authority. Consent and access to land for the proposed 2D seismic survey shall be channel to the relevant traditional authority through the Regional Council. Written request for consent shall be send through the Office of Governors for Kavango West and East Regions.

3.3.3 Water Legislation

Water Act 54 of 1956 under the Minister of Agriculture, Water and Land Reform (MAWLR) provides for the control, conservation and use of water for domestic, agricultural, urban, and industrial purposes. In terms of Section 6, there is no right of ownership in public water and its control and use is regulated and provided for in the Act. In accordance with the Act, the ongoing exploration operations must ensure that mechanisms are implemented to prevent water pollution. Certain permits will also be required to abstract groundwater as well as for water works which is not required for the proposed 2D seismic survey operations. The broad definition of water works will include the reservoir on Site (as this is greater than 20,000m$^3$), water treatment facilities and pipelines not applicable for the proposed 2D seismic survey. Due to the water scarcity of the area, all water will be recycled (including domestic wastewater as may be applicable). The Act may require the Proponent to have a wastewater discharge permit for discharge of effluent from the camp site if not equipped with portable chemical toilets.

3.3.4 Atmospheric Pollution Prevention Legislation

The Atmospheric Pollution Prevention Ordinance, 11 of 1976 falling under the Ministry of Health and Social Services (MHSS) provide for the prevention of the pollution of the atmosphere, and for matters incidental thereto. Part III of the Act sets out regulations pertaining to atmospheric pollution by smoke. While preventative measures for dust atmospheric pollution are outlined in Part IV and Part V outlines provisions for Atmospheric pollution by gases emitted by vehicles.

3.3.5 Labour, Health and Safety Legislations


In terms of the Health Safety and Environment (HSE), the Labour Act, 2007 protects employees and every employer shall, among other things: provide a working environment that is safe, without risk to the health of employees. and that has adequate facilities and arrangements for the welfare of employees, provide and maintain plant, machinery and systems of work, and work processes, that are safe and without risk to the health of employees, and ensure that the use, handling, storage or transportation of hazardous materials or substances is safe and without risk to the health of employees. All hazardous substances shall have clear exposure limits and the employer shall provide medical surveillance, first-aid and emergency arrangements as fit for the operation.

3.3.6 Coronavirus (COVID-19) Pandemic, Emergencies and Health Restrictions

The proposed 2D seismic survey operations will mobilisation of equipment and limited specialist personnel from abroad. The current global Coronavirus (COVID-19) pandemic and the associated State of Emergencies and health restrictions globally will result in some delays and logistic disruptions. Locally, Namibia might have State of Health Emergency on top of the current escalating health restrictions under the Public and Environmental Health Act, 2015 (Act No. 1 of 2015) that may also affect not equipment and specialist workforce mobilisation but also the actual field implementation of the project. The local COVID 19 health restrictions will affect the field campsite set-up, vehicles passengers and field survey and all aspects of the proposed project.

The Proponent through the Contractor and subcontractors shall adhere to the all the international, regional, and local COVID 19 health restrictions and protocols that may be in place at the time of conducting the survey.
3.3.7 Summary of Applicable National Legislations

The following is the summary of the important legislative that may be applicable to the proposed 2D seismic survey operations are:

- Namibian Constitution Articles 91(c) and 95.
- Environmental Management Act (No. 7 of 2007) and Regulations (2012).
- Water Act, 1956, Act No. 54 of 1956.
- Public and Environmental Health Act, 2015 (Act No. 1 of 2015)
- Health Act (No. 21 of 1988).
- Air Quality Act (No. 39 of 2004).
- Atmospheric Pollution Prevention Act (No. 45 of 1965).
- Communal Land Act (No. 10 of 2002).
- Communal Land Reform Amendment Act (No. 13 of 2013).
- Forestry Act (No. 12 of 2001) and Forest Amendment Act (No. 13 of 2005).
- National Heritage Act (No. 27 of 2004).
- Nature Conservation Amendment Act (No. 5 of 1996).
- Nature Conservation Ordinance (No. 4 of 1975).
- Soil Conservation Act (No. 70 of 1969), and.
- Traditional Authorities Act (No. 17 of 1995).

3.4 Regulatory Agencies and Permits Register

3.4.1 Key Regulatory Permits and Agencies

Government agencies with permits responsibilities over the proposed project activities are shown in Table 3.1. Table 3.2 shows the relevant permits / licenses required with respect to the proposed 2D seismic survey.

Namibia only has standards and guidelines with respect to the freshwater and wastewater and lacks gaseous and noise limits. The comparative water quality guideline is shown in Table 3.3. The industrial effluent likely to be generated by the proposed operations if any, must comply with provisions of the Government Gazette No 217 dated 5 April 1962 (Table 3.4).
Table 3.1: Government agencies with permits responsibilities over the proposed project activities.

<table>
<thead>
<tr>
<th>AUTHORITY</th>
<th>TYPE OF AUTHORISATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Office of the Environmental Commissioner (OEC), Ministry of Environment, Forestry and Tourism</td>
<td>Issue of Environmental Clearance Certificate (ECC) based on the review of the Environmental Assessments (EA) Reports prepared in accordance with the Environmental Management Act (2007) and the Environmental Impact Assessment Regulations, 2012</td>
</tr>
<tr>
<td>Ministry of Mines and Energy (MME)</td>
<td>Competent Authority overseeing all matters related to petroleum exploration and production activities in Namibia. MME is responsible for issuing of all types of Petroleum Licenses / Authorisation.</td>
</tr>
<tr>
<td>Ministry of Agriculture, Water and Land Reform</td>
<td>The Directorate of Resource Management within the Department of Water Affairs (DWA) at the MAWLR is currently the lead agency responsible for management of surface and groundwater utilisation through the issuing of abstraction permits and waste water disposal permits. DWA is also the Government agency responsible for water quality monitoring and reporting. The National Botanical Research Institute’s (NBRI) mandate is to study the flora and vegetation of Namibia, to promote the understanding, conservation and sustainable use of Namibia’s plants for the benefit of all. The Directorate of Forestry (DOF) is responsible for issuing of forestry permits with respect to harvest, transport, and export or market forest resources.</td>
</tr>
<tr>
<td>Kavango West and East Regional Councils</td>
<td>Overall responsibility of management of regional land resources and allocation of communal land user rights as may be required by the proposed project. Any Lease Agreement or surface land user rights in Communal Land must be approved by the Minister of Urban and Rural Development</td>
</tr>
<tr>
<td>Kavango West and East Regions Traditional Authorities</td>
<td>Traditional authorities in Namibia are the custodians of State land falling within authority of the respective tribal authority. With the approval of the Regional Land Boards, traditional authorities are responsible for allocation communal land user rights to the local communities. Consent to use communal land for the proposed 2D seismic survey shall be obtained from the relevant traditional authorities as may be applicable.</td>
</tr>
</tbody>
</table>

Table 3.2: Summary of the permit register.

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>APPLICABLE LEGISLATION</th>
<th>PERMITTING AUTHORITY</th>
<th>ASSESSMENT RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental Clearance Certificate (ECC) for proposed 2D Seismic Survey</td>
<td>Environmental Management Act (2007) and the Environmental Impact Assessment Regulations, 2012</td>
<td>Ministry of Environment, Forestry and Tourism (MEFT)</td>
<td>Still to be Issued</td>
</tr>
<tr>
<td>Discharge of effluents or construction of effluent facility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Removal, disturbances, or destruction of bird eggs</td>
<td>Nature Conservation Ordinance 4, 1975.</td>
<td>Ministry of Environment, Forestry and Tourism (MEFT)</td>
<td>No removals of protected species or mature trees anticipated because the activities will only require the widening the already existing tracks as may be applicable</td>
</tr>
<tr>
<td>Removal, disturbance of protected plants.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Removal, destruction of indigenous trees, bushes, or plants within 100 yards of stream or watercourse.</td>
<td>Forestry Act, 12 of 2001.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 3.3: Comparison of selected guideline values for drinking water quality (after Department of Water Affairs, 2001).

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter</td>
<td>Value (GV)</td>
<td>Proposed Parameter Value</td>
<td>Maximum Admissible Concentration (MAC)</td>
<td>Maximum Contaminant Level (MCL)</td>
<td>Group A Excellent Quality</td>
</tr>
<tr>
<td>Temperature</td>
<td>t °C</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Hydrogen ion concentration</td>
<td>pH, 25°C</td>
<td>R &lt;8.0</td>
<td>6.5 to 9.5</td>
<td>5.5 to 9.5</td>
<td>4.0 to 11.0</td>
</tr>
<tr>
<td></td>
<td>EC, 25°C mS/m</td>
<td>-</td>
<td>280 - 45</td>
<td>150 300 400</td>
<td>&gt;400</td>
</tr>
<tr>
<td>Total dissolved solids</td>
<td>TDS mg/l</td>
<td>R 1000</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total Hardness</td>
<td>CaCO₃ mg/l</td>
<td>-</td>
<td>300 650 1300</td>
<td>&gt;1300</td>
<td></td>
</tr>
<tr>
<td>Aluminium</td>
<td>Al mg/l</td>
<td>R 200 200</td>
<td>S 50-200</td>
<td>150 500 1000</td>
<td>&gt;1000</td>
</tr>
<tr>
<td>Ammonia</td>
<td>NH₄⁺ mg/l</td>
<td>R 1.5 0.5 0.05 0.5</td>
<td>1.5 2.5 5.0</td>
<td>&gt;5.0</td>
<td></td>
</tr>
<tr>
<td>Carbonate</td>
<td>PO₄³⁻ mg/l</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Chloride</td>
<td>Cl− mg/l</td>
<td>R 5 5</td>
<td>5 C 5</td>
<td>300 650 1300</td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td>Ca mg/l</td>
<td>-</td>
<td>-</td>
<td>150 200 400</td>
<td>&gt;400</td>
</tr>
<tr>
<td>Cerium</td>
<td>Ce mg/l</td>
<td>-</td>
<td>-</td>
<td>375 500 1000</td>
<td>&gt;1000</td>
</tr>
<tr>
<td>Chloride</td>
<td>CaCO₃⁺ mg/l</td>
<td>-</td>
<td>-</td>
<td>375 500 1000</td>
<td>&gt;1000</td>
</tr>
<tr>
<td>Chromium</td>
<td>Cr mg/l</td>
<td>R 250 250 - 25</td>
<td>S 250</td>
<td>250 600 1200</td>
<td>&gt;1200</td>
</tr>
<tr>
<td>Cobalt</td>
<td>Co mg/l</td>
<td>-</td>
<td>-</td>
<td>250 500 1000</td>
<td>&gt;1000</td>
</tr>
<tr>
<td>Copper after 12 hours in pipe</td>
<td>Cu mg/l</td>
<td>P 2000</td>
<td>2 100</td>
<td>1000 2000</td>
<td>&gt;2000</td>
</tr>
<tr>
<td>Cyanide</td>
<td>CN mg/l</td>
<td>-</td>
<td>-</td>
<td>100 200 400</td>
<td>&gt;400</td>
</tr>
<tr>
<td>Fluoride</td>
<td>F⁻ mg/l</td>
<td>1.5 1.5</td>
<td>at 8 to 12 °C: 1.5</td>
<td>C 4 1.5 2.0</td>
<td>&gt;3.0</td>
</tr>
<tr>
<td>Gold</td>
<td>Au g/l</td>
<td>-</td>
<td>-</td>
<td>2 8 10</td>
<td>&gt;10</td>
</tr>
<tr>
<td>Hydrogen sulphide</td>
<td>H₂S mg/l</td>
<td>R 50</td>
<td>-</td>
<td>1000 500</td>
<td></td>
</tr>
<tr>
<td>Iron</td>
<td>Fe mg/l</td>
<td>R 300 200</td>
<td>50 200</td>
<td>100 200 400</td>
<td>&gt;2000</td>
</tr>
<tr>
<td>Lead</td>
<td>Pb g/l</td>
<td>10 10</td>
<td>50 C TT#</td>
<td>50 100 200</td>
<td>&gt;2000</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Mg mg/l</td>
<td>P 30 30</td>
<td>S 30 50</td>
<td>250 600 1200</td>
<td>&gt;1200</td>
</tr>
<tr>
<td>Manganese</td>
<td>Mn mg/l</td>
<td>P 50 50</td>
<td>-</td>
<td>50 50 1000</td>
<td>&gt;1000</td>
</tr>
<tr>
<td>Mercury</td>
<td>Hg g/l</td>
<td>P 1 1</td>
<td>C 2 C 5</td>
<td>5 20</td>
<td>&gt;20</td>
</tr>
<tr>
<td>Nickel</td>
<td>Ni g/l</td>
<td>P 20 20</td>
<td>-</td>
<td>250 500 1000</td>
<td>&gt;1000</td>
</tr>
<tr>
<td>Nitrate*</td>
<td>NO₃⁻ mg/l</td>
<td>P 50 50</td>
<td>25 50</td>
<td>45 90 180</td>
<td>&gt;180</td>
</tr>
<tr>
<td>Nitrite*</td>
<td>NO₂⁻ mg/l</td>
<td>P 50 50</td>
<td>25 50</td>
<td>45 90 180</td>
<td>&gt;180</td>
</tr>
<tr>
<td>Oxygen, dissolved</td>
<td>O₂ % sat.</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>PO₄³⁻ mg/l</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Potassium</td>
<td>K mg/l</td>
<td>-</td>
<td>-</td>
<td>200 400 800</td>
<td>&gt;800</td>
</tr>
<tr>
<td>Selenium</td>
<td>Se g/l</td>
<td>10 10</td>
<td>10 C 50</td>
<td>20 50 100</td>
<td>&gt;1000</td>
</tr>
<tr>
<td>Silver</td>
<td>Ag g/l</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Sodium</td>
<td>Na mg/l</td>
<td>R 200 200</td>
<td>20 175</td>
<td>100 400 800</td>
<td>&gt;800</td>
</tr>
<tr>
<td>Sulphate</td>
<td>SO₄²⁻ mg/l</td>
<td>R 250 250</td>
<td>25 250</td>
<td>250 600 1200</td>
<td>&gt;1200</td>
</tr>
<tr>
<td>Tellurium</td>
<td>Te g/l</td>
<td>-</td>
<td>-</td>
<td>2 5 10</td>
<td>&gt;10</td>
</tr>
<tr>
<td>Thallium</td>
<td>Tl g/l</td>
<td>-</td>
<td>-</td>
<td>2 5 10</td>
<td>&gt;10</td>
</tr>
<tr>
<td>Tin</td>
<td>Sn g/l</td>
<td>-</td>
<td>-</td>
<td>C 2 C 5</td>
<td>&gt;20</td>
</tr>
<tr>
<td>Titanium</td>
<td>Ti g/l</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Zinc after 12 hours in pipe</td>
<td>Zn g/l</td>
<td>R 3000</td>
<td>-</td>
<td>100 500 1000</td>
<td></td>
</tr>
</tbody>
</table>

P: Provisional; R: May give reason to complaints from consumers; C: Current; P: Proposed; S: Secondary; TT: Treatment technique in lieu of numeric MCL; EC, 25°C: Temperature; 2D Seismic Survey Operations - 75 - Final Scoping Report for PEL 73-Feb 2021
Table 3.4: R553 Regional Standards for Industrial Effluent, in Government Gazette No 217 dated 5 April 1962.

<table>
<thead>
<tr>
<th>Colour, odour and taste</th>
<th>The effluent shall contain no substance in concentrations capable of producing colour, odour or taste</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>Between 5.5 and 9.5</td>
</tr>
<tr>
<td>Dissolved oxygen</td>
<td>At least 75% saturation</td>
</tr>
<tr>
<td>Typical faecal coli</td>
<td>No typical faecal coli per 100 ml</td>
</tr>
<tr>
<td>Temperature</td>
<td>Not to exceed 35 °C</td>
</tr>
<tr>
<td>Chemical demand oxygen</td>
<td>Not to exceed 75 mg/l after applying a correction for chloride in the method</td>
</tr>
<tr>
<td>Oxygen absorbed</td>
<td>Not to exceed 10 mg/l</td>
</tr>
<tr>
<td>Total dissolved solids (TDS)</td>
<td>The TDS shall not have been increased by more than 500 mg/l above that of the intake water</td>
</tr>
<tr>
<td>Suspended solids</td>
<td>Not to exceed 25 mg/l</td>
</tr>
<tr>
<td>Sodium (Na)</td>
<td>The Na level shall not have been increased by more than 50 mg/l above that of the intake water</td>
</tr>
<tr>
<td>Soap, oil and grease</td>
<td>Not to exceed 2.5 mg/l</td>
</tr>
<tr>
<td>Other constituents</td>
<td>Residual chlorine 0,1 mg/l as Cl</td>
</tr>
<tr>
<td></td>
<td>Free &amp; saline ammonia 10 mg/l as N</td>
</tr>
<tr>
<td></td>
<td>Arsenic 0,5 mg/l as As</td>
</tr>
<tr>
<td></td>
<td>Boron 1,0 mg/l as B</td>
</tr>
<tr>
<td></td>
<td>Hexavalent Cr 0,05 mg/l as Cr</td>
</tr>
<tr>
<td></td>
<td>Total chromium 0,5 mg/l as Cr</td>
</tr>
<tr>
<td></td>
<td>Copper 1,0 mg/l as Cu</td>
</tr>
<tr>
<td></td>
<td>Phenolic compounds 0,1 mg/l as phenol</td>
</tr>
<tr>
<td></td>
<td>Lead 1,0 mg/l as Pb</td>
</tr>
<tr>
<td></td>
<td>Cyanide and related compounds 0,5 mg/l as CN</td>
</tr>
<tr>
<td></td>
<td>Sulphides 1,0 mg/l as S</td>
</tr>
<tr>
<td></td>
<td>Fluorine 1,0 mg/l as F</td>
</tr>
<tr>
<td></td>
<td>Zinc 5,0 mg/l as Zn</td>
</tr>
</tbody>
</table>

3.5 International Standards, Treaties and Protocols

3.5.1 Applicable International Standards

The Constitution of the Republic of Namibia, the Environmental Management Act, (EMA), 2007, (Act No. 7 of 2007) and the Environmental Impact Assessment (EIA) Regulations No. 30 of 2012 as well as other associated laws with respect to exploration, petroleum exploration and production, land, energy, labour and health and safety all provides for the mechanism of assessing key issues associated with development projects in Namibia.

The only key missing components to the regulatory frameworks in Namibia are benchmarks, limits, standards, and guidelines with respect to gaseous, liquid, and solid emissions. However, in the absence of national gaseous, liquid, and solid emission limits for Namibia, the proposed project shall target the Multilateral Investment Guarantee Agency (MIGA) gaseous effluent emission level and liquid effluent emission levels (Table 3.5). Noise abatement measures must target to achieve either the levels shown in Table 3.6 or a maximum increase in background levels of 3 dB (A) at the nearest receptor location off-site (MIGA guidelines).
Table 3.5: Liquid effluent emission levels (MIGA /IFC).

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Max. Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>6.9</td>
</tr>
<tr>
<td>Total suspended solids</td>
<td>50 mg/l</td>
</tr>
<tr>
<td>Total metals</td>
<td>10 mg/l</td>
</tr>
<tr>
<td>Phosphorous (P)</td>
<td>5 mg/l</td>
</tr>
<tr>
<td>Fluoride (F)</td>
<td>20 mg/l</td>
</tr>
<tr>
<td>Cadmium (Cd)</td>
<td>0.1 mg/l</td>
</tr>
</tbody>
</table>

Table 3.6: Noise emission levels (MIGA /IFC).

<table>
<thead>
<tr>
<th>Receptor</th>
<th>Maximum Allowable Leq (hourly), in dB(A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential, institutional, educational</td>
<td>Day time (07:00 – 22:00)</td>
</tr>
<tr>
<td></td>
<td>55</td>
</tr>
<tr>
<td>Industrial, commercial</td>
<td>70</td>
</tr>
</tbody>
</table>

3.5.2 International and Regional Treaties and Protocols

Article 144 of the Namibian Constitution provides for the enabling mechanism to ensure that all international treaties and protocols are ratified. All ratified treaties and protocols are enforceable within Namibia by the Namibian courts and these include the following:

- The Paris Agreement, 2016.
- Convention to Combat Desertification, 1994. and
 STOCKHOLM CONVENTION OF PERSISTENT ORGANIC POLLUTANTS, 2001, AND.

SOUTHERN AFRICA DEVELOPMENT COMMUNITY (SADC) PROTOCOL ON ENERGY.

3.5 Recommendations on Regulatory Framework

The regulatory framework with respect to the proposed 2D seismic survey has been reviewed during the EIA and EMP stages. The proposed 2D seismic survey operation shall meet all the applicable national legislation, regulations, standards, and guidelines as well as international and regional regulatory frameworks, standards, treaties, and protocol as well as the International Association of Geophysical Contractors (IAGC) industry standards for conducting onshore seismic survey operations. The IAGC is the global trade association representing all segments of the geophysical and exploration industry (www.iagc.org). The IAGC provides guidance materials and industry best practices for land seismic operations.

It is hereby recommended that the Proponent shall comply with the provisions of all relevant and applicable national regulatory frameworks and requirements in Namibia. Local community, cultural, religious, and traditional practices as well as fair labour relations and local hire shall always be observed with continuous engagement with the traditional authorities and Regional Councils as may be applicable.
4. RECEIVING ENVIRONMENT

4.1 Physical Geography

The local landscape is characterised by gentle undulating sandy topography of the densely forested / vegetated sandy Kalahari Dune Belt. The general topographic setting of the profiles / survey line trends varies from 1130 to 1173 meters above mean sea level (amsl) for the topographically lower and higher laying areas respectively.

Some parts of the targeted survey area are fenced under the communal land use / government resettlement programme.

4.2 Climate and Land Use

4.2.1 Climatic Components

The proposed project area is located in the north central part of Namibia with daytime warm to hot temperatures throughout the year, while the nights are mild to cool. The mean annual rainfall is highly variable between 400 and 600 mm per year (Fig. 4.1).

The distribution of rainfall is extremely seasonal with almost all the rain falling in summer - from October to April with occasional with mean annual gross evaporation is between 2600-2800 mm (Fig. 4.1).

4.2.2 Land Use

The land uses in the general area is mainly communal / subsistence farming comprising cattle, donkeys, seasonal crop farming, grass, and wood / timber harvesting. Subsistence seasonal (January to April) crop farming of millet and maize are centred on widely spaced communal villages especially within and along the Omatako and all associated Ephemeral Rivers channels, plains, and depressional topographically low area.

The villages are also centred around communal water points or near schools or rural clinics where water is readily available. The key farming areas falls within the undulating and depressional zones of the east-west trending Kalahari Dunes where local soils are slight fertile.

Forestry clearing for subsistence agriculture is dominates in the region with slash and burn being used which sometimes run out of control and destroys larger portions of the forest annually.

The following is the summary of some of the common general threats to the natural environment and habitats of the general project area:

(i) Accelerated allocation of communal leaseholds resulting in forestry clearing.
(ii) Subsistence communal crop farming centred on forestry clearing, slash and burn practices.
(iii) Timber and wood harvesting, and.
(iv) Overgrazing due to increased number of animals.
4.3 Fauna and Flora Diversity

4.3.1 Overview

A comprehensive literature study (desktop) of the vertebrate fauna (i.e. amphibians, birds, mammals and reptiles) and flora (i.e. larger trees/shrubs (>1m in height) and grasses) expected to occur in the general Kavango Basin – Blocks 1819 and 1820 [PEL 73] was conducted during December 2018. This was followed up by fieldwork conducted in November and December 2020 (current study) to determine the effect that the proposed ground seismic survey may have on the bio-physical environment (vertebrate fauna and flora) within the development area and immediate surroundings and especially along the proposed seismic survey lines.
This literature review was to determine the actual as well as potential vertebrate fauna and flora associated with the general area commonly referred to as the Tree Savanna and Woodlands (Northern Kalahari) (Giess 1971) or a combination of North-eastern Kalahari Woodland; Eastern Drainage; Northern Kalahari and Omatako Drainage, with the North-eastern Kalahari Woodland being the dominant vegetation type (Mendelsohn et al. 2002). The vegetation structure is classified as broadleaved woodlands (Mendelsohn et al. 2002).

The general area is regarded as "medium" in overall (all terrestrial species) diversity (Mendelsohn et al. 2002). Overall terrestrial endemism in all species in the area on the other hand is "low" (Mendelsohn et al. 2002). The overall diversity and abundance of large herbivorous mammals (big game) is viewed as "average" with oryx, kudu and giraffe dominant especially in areas bordering the National Parks while the overall diversity and density of large carnivorous mammals (large predators) is determined as "average" with 1-5 species expected e.g. leopard, brown hyena, spotted hyena, cheetah and wild dog (Mendelsohn et al. 2002).

It is estimated that at least 67 species of reptile, 32 amphibian, 116 mammal and 210 bird species (breeding residents) are known to or expected to occur in the general Kavango East and West regions of the proposed project area.

According to Maggs (1998) there are approximately 4344 higher plant species with the most species being within the grasses (422), composites (Asteraceae) (385), legumes (Fabaceae) (377) and fygies (Mesembryanthemaceae) (177), recorded from Namibia. Total species richness depends on further collecting and taxonomic revisions. High species richness is found in the Okavango, Otavi/Karsveld, Kaokoveld, southern Namib and Central Highland (Windhoek Mountains) areas. Endemic species in approximately 687 species in total are mainly associated with the Kaokoveld (north-western) and the succulent Karoo (south-western) Namibia. The major threats to the floral diversity in Namibia are:

- Conversion of the land to agriculture (with associated problems), and
- Poorly considered development (Maggs 1998, Mendelsohn et al. 2002).

A large variety of deciduous trees are found in the Savannah and Woodlands [Northern Kalahari area] vegetation type. The grasses are usually hard and unpalatable in this area with Anthephora pubescens, Brachiaria nigropedata and Schmidia pappophoroides viewed as the climax grasses in the open savannah areas (Giess 1971).

The general area has a "medium" plant diversity of between 300-399 species although the Okavango River to the north has a higher diversity (400-499 species). The endemism is viewed as "low" throughout with no species viewed as endemic (Mendelsohn et al. 2002). Simmons (1998a) puts the plant endemism in the general area at between 1-10 species depending on the locality. These estimates are limited to "higher" plants as information regarding "lower" plants is sparse. The greatest variants affecting the diversity of plants are habitat and climate with the highest plant diversity generally associated with high rainfall areas. Pockets of high diversity are found throughout Namibia in "unique" habitat often transition zones e.g. mountains, inselbergs, etc. in and riparian areas.

Furthermore, Mendelsohn et al. (2002) views the overall plant production as "very" to extremely high while the variation in plant production is mostly "very" low to low (0-10%) although dependant on the location. The grazing potential is viewed as "low" to average in the general area while the browse potential is viewed as "good". Bush thickening (encroachment) is not viewed as problematic in the general area (Bester 1996, Cunningham 1998). The risk of farming is viewed as "low" with the tourism potential viewed as "average" to high (Mendelsohn et al. 2002).

It is estimated that at least 107 species of larger trees and shrubs (>1m in height) and up to 111 species of grasses are known to or expected to occur in the general area, none of which are viewed as endemic species.
4.3.2 Important Fauna and Flora Species

4.3.2.1 Reptiles

The most important species are viewed as the 2 endemics (*Ichnotropis grandiceps* and *Lygodactylus bradfieldi*), 3 species classified as rare (*Lycophidion multimaculatum*, *Psammophis jallae*, *Causus rhombeatus*) and 6 species classified as vulnerable (*Stignochelys pardalis*, *Psammobates oculiferus*, *Kinixys speki*, *Python natalensis*, *Varanus albigularis*, *Varanus niloticus*) from the general area. Furthermore, *Ichnotropis grandiceps*, is also classified as data deficient by the IUCN (2020), supporting its importance.

4.3.2.2 Amphibians

The most important species from the area is the giant bullfrog (*Pyxicephalus adspersus*) with “population decreasing” according to the IUCN (2020) as it is consumed as food throughout its range.

4.3.2.3 Mammals

The most important species from the general area are probably those classified as rare (*Nycteris hispida*, *Kerivoula argentata*, *Kerivoula lanosa*, *Mastomys shortridgei*, *Civittictis civetta*, *Paracynictis selousi*) and endangered (*Lycaon pictus*, *Lutra maculicollis*, *Equus (burchellii) quagga*) under Namibian legislation and those classified by the IUCN (2020) as endangered (*Lycaon pictus*), vulnerable (*Loxodonta africana*, *Smutsia (Manis) temminckii*, *Acinonyx jubatus*, *Panthera pardus*, *Panthera leo*, *Hippopotamus amphibious*, *Giraffa camelopardalis*) and near threatened (*Hipposideros vittatus*).

However, some of the above species e.g. other, hippo, etc. are only associated with the Okavango River and not linked to the key exploration areas of interest. The most important species expected to occur in the general area would be the African wild dog (*Lycaon pictus*) and pangolin (*Smutsia (Manis) temminckii*).

4.3.2.4 Birds

The most important species are viewed as those classified as endangered (hooded vulture, white-backed vulture, tawny eagle, martial eagle, bateleur, southern ground-hornbill), vulnerable (secretarybird, white-headed vulture, lappet-faced vulture and) and near threatened (marabou stork, peregrine falcon, kori bustard) from Namibia (Simmons et al. 2015) as well as those classified by the IUCN (2020) as critically endangered (hooded vulture, white-headed vulture, white-backed vulture), endangered (lappet-faced vulture), vulnerable (secretarybird, tawny eagle, martial eagle, southern ground-hornbill) and near threatened (bateleur, kori bustard).

4.3.2.5 Trees and Shrubs

The most important species expected to occur in the general area are *Baikiaea plurijuga* (Protected F#; LR-nt), *Burkea africana* (Protected F#), *Guibourtia coleosperma* (Protected F#), *Dialium engleranum* (Protected F#), *Philenoptera violacea* (Protected F#), *Pterocarpus angolensis* (Protected F#; LR-nt), *Schinziophyton rautanenii* (Protected F#), *Sclerocarya birrea* (Protected F#) and various *Strychnos* species (Protected F#).

4.3.2.6 Grass

The grasses commonly used for thatching i.e. *Eragrostis pallens* and *Cymbopogon* species which also have economic value, are the important grasses in the area.
4.4 Socioeconomic Settings

4.4.1 Kavango West and East Regions

Nkurenkuru is the capital of the Kavango West Region and it's situated about 140 km west of Rundu the regional Capital of Kavango East region. The boundary between Kavango East and West generally follows the Omatako-Omuramba River.

The Kavango West Region covers an area of 24,591.27 km² and lies directly south of Angola and the Kavango River and east of Ohangwena and Oshikoto Regions, north of Ojoozondjupa Region and west of the Kavango East Region. Kavango West Region is subdivided into eight electoral constituencies namely: Kapako, Mankumpi, Mpungu, Musese, Ncamangoro, Ncuncuni, Nkurenkuru, and Tondoro (Annex 3).

Kavango East Region covers an area of 23,987 km² and is bordered by the Kavango West, Ojoozondjupa and Zambezi Regions. The constituencies in Kavango East Region include: Rundu Urban, Rundu Rural, Mashare, Mukwe, Ndiyona and Ndonga Linena.

Both regions and the project area are characterised by an extremely uneven population distribution with high levels of poverty. The interior of the regions are very sparsely inhabited, while the northernmost strip, especially along the Kavango River, has a high population concentration (National Planning Commission, 2012). According to Mendelsohn et al. (2006), the general livelihood of the people in the two regions is derived from small-scale agro-pastoralism, supported by fishing along the Okavango River. Overall, subsistence agriculture comprising animal husbandry (cattle and goats), cultivation of millet and maize and timber logging are an integral part of the day to day survival of the rural population within the project.

The following is the summary of the socioeconomic settings of the proposed project area:

- The population of Ncamangoro Constituency is 7043 people, which is 8.1% people of Kavango West Region. Mashare Constituency has 8885 people, which is 11.2% of Kavango East population.
- Inter-Census growth rates are 1.6% for Kavango East Region and 0.6% for Kavango West Region.
- Gender distribution is slightly inclined towards higher female shares. Mashare Constituency had 52% of female and 48% of male population and Ncamangoro Constituency had 51.9% female and 48.1% male population.
- The population density in both regions is above national average. 6.2 people for km² in Kavango East was and 3.6 people for 1 km² in Kavango West.
- Inter-census recorded that both Kavango Regions have high proportion of persons with disabilities, particularly high was in Kavango West (7.6%). This is the highest in Namibia. East recorded 6.0% of persons with disabilities.
- Ncamangoro Constituency falls within the Mbunza Traditional Authority and Mashare Constituency falls within Sambyu Traditional Authority.
- Rukavango-speaking people constitute the largest language group in Kavango (79.4% of the population), and San constitute 0.4% of the region’s population.
- Mashare Constituency’s adult literacy rate stood at 72% and Ncamangoro recorded only 63.3% of people being literate. Literacy rates in both constituencies are not only below their respective regional average rates, but they are among lowest in Namibia.
- Kavango Regions (East and West) has the largest population of unemployed youth aged 15-35 and the highest unemployment rates. Unemployment in Kavango East is 39.6% and in
Kavango West stands at 36.4%. Unemployment in Ncamangoro Constituency stood at 52.2%. Unemployment rate for female is higher than for male.

- Kavango regions have highest incidence of poverty, 53% of all population. Poverty is defined as the number of households who are unable to afford sufficient resources to satisfy their basic needs.

- The main employment industries in Kavango East and Kavango West is agriculture, forestry and fisheries. Around 45.95% of employed in Kavango East are in the agriculture, forestry and fisheries sector and in Kavango West the share is even larger 80.04%.

- The Kavango West and East Regions are relatively well covered with a network of roads; unfortunately, most of these roads are gravel or sandy roads that make travel difficult. Kavango East Region has one airport, at Rundu, that accommodates national flights. Several smaller airstrips cater for the tourism sector especially in the eastern part of the region.

- Nevertheless, people living deep in the interior of both regions are far from social infrastructure, thus access to education and medical treatment is difficult.

- The communities living in the northern part of the Kavango West and Kavango East Regions along the road from Nkurenkuru to Rundu and Rundu to Divundu road are relatively well connected to the national electricity grid. The remainder of the rural communities situated away from the river and the main road are connected mostly with off-grid facilities that utilise either solar power systems or diesel power systems.

- The Okavango River is the main source of water for the people living along the river, and for their livestock, whereas villages away from river depend entirely on groundwater from boreholes supplied by MAWLF and in some cases from seasonal pans. The urban areas -settlements and towns are provided with water by the NamWater.

- The main economic activities of both Kavango Regions are agriculture, mainly small-scale mahangu farming, providing some food self-sufficiency but little food security; aquaculture; timber harvesting; tourism, particularly in Kavango East Region; and sand mining activities.

- There are a number of community forests within the Kavango East and Kavango West Regions. Two (2) community forests in Kavango West and ten (10) community forests in Kavango East. The proposed area is not located within the community forest areas, however the existing roads and tracks to be used for the proposed 2D seismic survey cut across community forestry such as the Gcwatjinga and Mbeyo. Illegal harvesting of timber in Kavango Regions is on rise and attributed to the high demand for timber worldwide, and.

- Tourism is mainly in Kavango East Region. In Kavango West Region it is limited and undeveloped. Tourism in the Kavango East Region is mostly focused on the eastern part of the region around Divundu, to some extent in the central part of the region next to the Kavango River and in Rundu. This is associated with the fact that most of the biodiversity, wildlife and scenic areas are found in the eastern part of the region. Kavango East Region falls within the Kavango Zambezi Transfrontier Conservation Area (KAZA TFCA).

The EIA and EMP will assess the potential positive and negative impacts and offers enhancement measures for positive impacts such as recruitment of local people along each survey line.

4.5 Subsurface Ground Components

4.5.1 Regional Geology and Petroleum System

The present-day Kalahari Basin owes its origin to the uplift of the Southern Africa continental margin during the break-up of African proto-type continent known as Gondwanaland (Summerfield, 1985); this tectonic event created what is now known as the Great Escarpment by uplifting the Southern African continental margin followed by the down-warping of the continental interior creating the
Kalahari Basin comprising the Kalahari Group sediments extending over much of Southern Africa (De Swardt and Bennet, 1974 and Fig. 4.2).

According to Summerfield (1985), further local tectonic activities associated with reactivation of D3 deformation events of the Damara Orogen and the Eastern African Rift System caused further subsidence along graben systems of the central basin favouring thick sediment accumulations and creation of sub-basins.

The western sub-basins within which the study area is situated are locally dissected by numerous parallel faults which form graben; the most notable grabens to this study being the Omatako Graben. It therefore suffices to say that the Omatako River is largely structural-controlled.

It is based on the above-mentioned land mark structural and geomorphic units that the vertical and horizontal segregation, mineralogical content, texture, and grain size of the sediments of the study area will be theoretically framed and evidently contextualized. This will be particularly so in the subsequent sections and in the discussion and conclusions of this study. And within that theoretical frame and contextual evidence, the hydrogeological settings (groundwater) investigations of the study area will be interrogated and framed into a concept, with acknowledgements of data and information limitations.

Regional geologic investigations of the Permian Karoo Seaway, including main Karoo Basin, Botswana Kalahari Basin and Namibian basins Karasburg, Nama, Waterberg, Huab and Owambo support potential for adequate thickness of resource-prone sediments. Preliminary analyses indicate basin depths supportive of oil and gas thermal maturation levels.

Reconnaissance Energy Namibia (Pty) Ltd has interpreted high resolution aero magnetic data documenting a very deep untested Kavango Basin with optimal conditions for preserving a thick interval of organic rich marine shales in the lower portion of the Karoo Super Group. Maximum depth to basement is estimated at over 9 kilometres. The company has also completed structural and geological interpretations of magnetic inversion profiles, backfilling the basin with stratigraphic section of Precambrian, Permian, and Cretaceous sediments (Fig. 4.3).

Reconnaissance Energy Namibia (Pty) Ltd’s interpretation strongly suggests that the formational equivalents to the Lower Ecca Group will be preserved in the untested deeper portions of the Kavango Basin. The company believes that these target sediments lie in a previously unrecognised Karoo Basin along major trans African lineaments that link northeast Namibia to the better-known Karoo rift basins in eastern Africa.

Reconnaissance Energy Namibia (Pty) Ltd’s geologic team has defined a beneficial structural framework and depositional basin configuration utilising a high-resolution aero-magnetic database. The company has developed a fully integrated structural inversion model for the entirety of the Kavango Basin defining a pull-apart basin with targetable half grabens capable of housing substantial thickness of Karoo-aged sediments and reef-prone Lower Paleozoic Units.
Figure 4.2: Lateral extent of Kalahari Group sediments (Source: Haddon, 2005).
4.5.2 Water Resources

4.5.2.1 Surface Water

The present drainage within the survey area, although largely ephemeral apart from the Okavango River are exorheic, meaning that it allows flow into other external bodies of water for example rivers, swamps, and lakes. In this context they all drain into the greater Okavango River. This is true except for the Fumbe Stream which is endorheic (allows no flow into other external body of water).

Of interest to hydrogeology about drainage is stream network density (Dd), stream network frequency (Df), stream network texture, stream network topology and slope variations because these drainage aspects closely relate to dynamic nature of river sections or basin portions, dominant processes within basins/river sections, geology and geomorphology of basins/river sections and inform processes like run-off, infiltration, overland flow, sediment response and through flow.

The survey area covers three basins, the Kavango 1 and the Kavango 2 dissected by the graben controlled Omatako Basin (Fig. 4.4). In the Kavango 1 Basin streams essentially flow south-north into the Okavango River; deviating from the regional slope and probably emphasizing local structural control, whereas in the Omatako Basin the Omatako River flows north east into the Okavango River. Streams in the Kavango 2 Basin flow along the regional north east slope. It should be noted here that rivers initially follow slope and then adjust to local geologic structure as they incise their beds.
Figure 4.4: Local drainage system of the general area covered by the proposed 2D seismic survey.

In context of the above referenced value of stream/river aspects, in the far north west of the study area is Mpuku stream (Kavango 1 Basin) which displays high tributary network frequency (inter stream spacing along the trunk stream) of approximately a stream tributary every 12 km compared to other streams of relatively same distance coverage like the Fontein stream draining Ncaute, Ncuncuni to Rundu. Another high tributary network frequency is observed along the first 67 km of the Omatako River from the southern border of the study area. In that section of the Omatako Basin the Omatako River has a tributary every 5.4 km; thereafter the Omatako River has no tributary for about 85 km.

About stream network density (sum of stream length per unit area of section of basin), km/km$^2$) the dissected portion of the Omatako Basin’s Dd is estimated at 0.033 whereas that of the Mpuku stream is approximately 0.072, meaning that the Mpuku Stream drainage area’s runoff potential is relatively two-fold more than that of the dissected portion of the Omatako River. However, it should be qualified here that stream density (Dd) values of less 5 (0.033 for Omatako River, and 0.072 for the Mpuku stream) imply coarse stream texture which is characteristic of dry regions with none perennial flow or flow only during rainy seasons.

These observations allow inference into the dynamic and active drainage portions of the study area. Portions outside the ones marked dynamic are either quiet or relatively less dynamic, and play roles of sediment and run-off accommodation, through flow, and infiltration sites. The two areas marked
dynamic portions in Fig. 4.4 are the relatively dynamic drainage portions of the study area, and it is expected that these are sites of erosion, run-off, and overland flow.

Drainage analysis efficiently links to surface-water Groundwater interaction, therefore the observations presented above offer an opportunity to infer the surface-water Groundwater interaction dynamics of the study area in view of preferential sites, losing or gaining, pathways, infiltration potential, and flow fields.

In the above given context and about surface-water groundwater interaction, it is important to note that the rivers/streams in the study area are of coarse stream texture and only flow in exceptionally wet seasons and for short periods, this keeps their stream beds above the groundwater table for most of the time. Therefore, when they flow after good rains, they tend to lose the water to the sub-surface flow, with high evapotranspiration. This becomes even more-so considering that they are low gradient streams (gradient of less than 2 %).

The Omatako River and are potentially areas of surface water ponding, infiltration, and groundwater through flow. Productive boreholes will then be preferable located in the last quarter of the active zone to the second half of the inactive zone, this inference is based on the observed relative high mass transport capacity and the observation that this section of the Omatako River cuts from the western banks and buries on the eastern banks of the channel. Therefore, productive boreholes in this section should be bias towards the eastern side of the river channel.

The proposed 2D seismic survey operations will be undertaken along existing roads and tracks with little to no interference to surface water system of the area (Plates 1.1 -1.24).

4.5.2.2 Hydrogeology

The geographic coverage and systematic hydrogeological investigations of the Kalahari Group in Namibia is limited to due to two cited factors; namely lack of mineral interests and that the area is sparsely inhabited (Wanke & Wanke, 2007; Jones, 2010).

The first concerted effort to study the hydrogeological potential of the Kalahari Group in general and in the Omatako Basin/graben in particular is that of the CSIR in 1982 when it was realized that Okarakara is becoming a population-growth point. Based on geophysical investigations (vertical electrical sounding) and core drilling of one exploration borehole, CSIR (1982) identified three hydrogeological units in the Kalahari Group; namely the upper, middle, and lower Kalahari. Of the three units, the middle Kalahari sandstone was recognized as the most promising aquifer of the three units, whereas the lower Kalahari is reported to be argillaceous and of poor water quality.

Most of the findings of the CSIR (1982) were confirmed by a drilling campaign by the Department of Water Affairs in 1996/1997 (DWA, 1997). Furthermore, DWA (1997) contends that where the saturated thickness of the middle Kalahari is less than 100 m, borehole yields tend to decline with decreasing saturated thickness.

Without ruling out that one consecutive study might have been influenced by the findings of the previous one, Kuells (1998-2000) in his then unfinished PHD study assumed a general concept of the middle Kalahari sandstones as a well-developed aquifer system within the stratigraphy of the Kalahari Group, and goes further to characterize the sandstone as a semi-consolidated to consolidated homogeneous productive aquifer which depends on both diffuse and direct recharge from sub-surface flows and from percolation following good rainfall events respectively. However, and probably influenced by the large geographic scale of his study, Simmonds (1999) contends that the aquifers of the Kalahari Group can be classified as either deltaic or Aeolian; characterizing them as low yielding, very fine sand, silty sand, and sandstone aquifers with clayey horizons.

Jones (2010) adds a bit of substance to the nature of the lower Kalahari aquifer beyond what CSIR (1982) contends as argillaceous and describes it as fluvial and lacustrine. This position tallies with that of Thomas and Shaw (1991) in which the lower Kalahari is described as a conglomerate and gravel unit capped by pink to red marls in parts. Furthermore, Thomas and Shaw (1991) distinguish two other units of the Kalahari Group relating to varicoloured sandstone probably equivalent to the middle
Kalahari and another unit starting with widespread calcrete, silcrete and other duricrust; probably signalling the onset of the upper Kalahari group. Jones (2010) relates the later (widespread calcrete and silcrete unit) to the onset of dry conditions and reduced denudation as the hydrological regime became seasonal following original perennial drainage becoming ephemeral and possible fragmentation of the drainage system into closed sub-basins.

Results from recent drilling of six boreholes all of them to a depth of 150 m at Katji na Katji (NamWAter, 2018) indicates a consistent stratification of fine sand with clayey horizons in the top 90 m followed either medium sand or sandstone from 90 to 150 m. Where there is fine to medium grained sand occurrence in the bottom 60 m, it would be calcareous on top and clayey at the bottom, Katji na Katji is situated within the study area about 40 km south west of the proposed drill sites.

Integration of the above presented information and evidence postulates a general hydrogeological concept with high transport capacity basal Kalahari unit consisting of conglomerate and gravels, this conceptual position is informed by several investigators (Boocock & Van Straten, 1962; Thomas & Shaw, 1991; Jones, 2010). Boocock & Van Straten (1962) contend that the basal gravels and conglomerate are extensive in the Kalahari Group and reflect the importance of the post Gondwanaland endorheic drainage system, whereas Thomas & Shaw (1991) state that marls are reportedly been found above the basal gravel but are confined to northern Namibia.

The second aquifer unit of the Kalahari in the study area is the medium sand and sandstone layer of the middle Kalahari, this aquifer although reported be consistent by Kuells (2000) is expected to be discontinuous in this conceptual model given evidence of drying conditions which followed the basal Kalahari in which the hydrological regime is reported to have been ephemeral with wide spread deposition of laterite and duricrust (alternate hot and wet conditions) and discontinuous clay horizons. Drilling at both Goblenz and Katji na Katji confirm the presence of this red to pink sandstone at the depth of around 150 m depending on where you are in the basin.

This study does recognise the presence of the largely Aeolian upper Kalahari but does not appreciate it as an aquifer. This position is informed by the low energy drainage nature of the upper Kalahari presented in fine and silty sediment. However, where local streams have been uplifted by igneous impalements i.e., the first 68 km of the Omatako River within the survey area up to the village of Ncaute the energy and mass transport capacity of the upper Kalahari can be considered as a local aquifer, particularly around stream banks where the stream channel has been burying and shifting away from. In this zone of the upper Kalahari water levels can be as shallow as 10 m and borehole depths of 70 m can yield up to 30 m3/h with very high variability, therefore this is not a well-developed aquifer system.

Based on the above give hydrogeological concept, the deep and regional groundwater flow system (Fig. 4.5) equivalent to the lower Kalahari aquifer unit benefits from direct recharge around the rim of the basin and from elevated outcrops, would characteristically artesian (marl & clay confining layer) with elevated total dissolved solids (TDS) due a long resident times, and therefore prone to poor water quality. This system is not expected to be shallower than 160 m except were elevated by igneous intrusions.

The middle Kalahari aquifer (Fig. 4.5), which is largely fine/medium grained sand and sandstone as stated earlier would benefit from leakage recharge from the upper Kalahari and is therefore expected to be semi-confined to confined in places, with limited storage capacity outside current or/and outside palaeo-stream channels. Water quality will be acceptable for human consumption along stream channels but may deteriorate away from existing or from palaeo-stream channels.

On the basis of the developed conceptual hydrogeology model (Fig. 4.5 and Table 4.1) of the study area, the Karoo sandstone/conglomerate and lower Kalahari aquifers are expected to be confined and therefore prone high hydraulic pressures during drilling, this applies to any significant water bearing layer in the Damara Aquifers, particularly fractured quartzite and dolomite/limestone formations. The depth of these aquifer units cannot be estimated but the onset of the Karoo is marked by gravity sediments i.e. the Dwyka Formation which is a conglomerate or tillite, whereas the onset of the Kalahari is also marked by fluviatile gravels and conglomerates. These two stratigraphic markers should
produce more water than others; that is besides fractured quartzite and dolomite/limestone of the Damara Sequence.

![Conceptual groundwater flow components around PEL 73.](image)

**Figure 4.5:** Conceptual groundwater flow components around PEL 73.

**Table 4.1:** Conceptual hydrogeology characteristics of the study area.

<table>
<thead>
<tr>
<th>GROUP / SEQUENCE</th>
<th>STRATIGRAPHIC UNIT</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaledhari</td>
<td>Fine and Silt</td>
<td>Aquitard, leaky</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Aquifer</td>
</tr>
<tr>
<td></td>
<td>Sandstone, Sand &amp; Clay</td>
<td>Aquifer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Low Yielding, locally high Yielding</td>
</tr>
<tr>
<td></td>
<td>Marl and Clay</td>
<td>Confining Layer</td>
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<tr>
<td></td>
<td>Conglomerate &amp; Gravel</td>
<td>Aquifer</td>
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<td>Karoo</td>
<td>Basalt/Sandstone</td>
<td>Aquitard/Weathered</td>
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<td>Damara</td>
<td>Schist/Quartzite/dolomite</td>
<td>Aquitard/Fractured</td>
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<tr>
<td></td>
<td></td>
<td>Conditional</td>
</tr>
</tbody>
</table>

**4.5.2.3 Water and Environment**

A generic water environment consists many measurable components and among others the important ones are rates of water flow, water flow direction, water stagnating/ponding, water flow pathways, replenishment of water sources, changes in storage, discharging of water from water bodies, physio-chemical, existing/expected organic load of the area and biological character of the water, flooding and depletion of water resources, water resources contamination as well as the terrestrial and aquatic life supported by water bodies.

The proposed 2D seismic survey operations will be undertaken on surface along existing roads and tracks with little to no implication and the vulnerability to subsurface groundwater resources.
4.6 Archaeology

4.6.1 Overview of Archaeological Resources in PEL 73

Previous systematic archaeological investigations of the Kavango East and West Regions revealed human occupations that predate the pre-colonial farming settlements. In addition to archaeological heritage, modern heritage of Kavango East and West Regions is characterised by remnants of numerous historic, sacred cultural sites as well as present-day community graves and cemeteries mainly along the Omatako River basin not affected by the proposed 2D seismic survey operations.

4.6.2 Archaeological Baseline Findings

The desk archaeological heritage impact assessment study has only identified a group of archaeological heritage sites within the footprint of the proposed project. These are located along the Omatako River basin between Ncaute and Taratara villages (Table 4.2 and Fig. 4.6). Additionally, a group of other sites whose quantity has not been established are also found south west of Omatako River basin.

These sites will not be impacted by the proposed 2D seismic survey operations neither are they vulnerable nor sensitive. However, it cannot be ruled out that other significant archaeological evidence of pre-colonial occupation will likely be found along the tributaries of the Omatako River basin mainly due to the presence of fresh water in the immediate area.

If they do occur, the nature of anticipated archaeological materials along the Omatako river course will likely be of diagnostic nature from Late Stone Age period due to the spread of the industry in this area. However, such surface artefacts will have no archaeological values because they will likely been already disturbed by extensive agricultural activities all along the Omatako river course (Plate 4.1).

Table 4.2: GPS coordinates of the identified archaeological sites reflected in Fig. 4.6.

<table>
<thead>
<tr>
<th>Site No.</th>
<th>GPS location</th>
<th>Region</th>
<th>Constituency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>18°13′54.72″S / 19°44′9.88″E</td>
<td>Kavango East</td>
<td>Mcuma/Chimpanda</td>
</tr>
<tr>
<td>2</td>
<td>18°21′50.17″S / 19°49′53.12″E</td>
<td>Kavango East</td>
<td>Shikambu</td>
</tr>
<tr>
<td>3</td>
<td>18°21′48.47″S / 19°51′24.65″E</td>
<td>Kavango East</td>
<td>Baramasono</td>
</tr>
<tr>
<td>4</td>
<td>18°11′1.21″S / 20°10′15.72″E</td>
<td>Kavango East</td>
<td>Baramasono</td>
</tr>
<tr>
<td>5</td>
<td>18°10′59.89″S / 20°11′18.68″E</td>
<td>Kavango East</td>
<td>Taratara</td>
</tr>
</tbody>
</table>
Figure 4.6: A group of archaeological sites (red dots, quantities not established) in relation to the proposed 2D seismic survey lines (red lines) to be conducted along existing roads and tracks. The blue lines indicate the Omatako Ephemeral River channels.
Plate 4.1: Extensive human induced disturbances including agricultural activities all along the Omatako river course that could have resulted in the disturbances of any archaeological resources in the area.
4.7 Stakeholder Consultations and Engagement

4.7.1 Overview

According to the Environmental Impact Assessment (EIA) Regulations No. 30 of 2012 and the Environmental Management Act, (EMA), 2007, (Act No. 7 of 2007), a person conducting a public consultation process must give notice to all potential Interested and Affected Parties (I&APs) of the application for ECC which is subjected to public consultation and participation process. The EIA Regulations clearly state that potential interested and affected parties must be provided with a reasonable opportunity to comment on the application under section 21(6) of the EIA Regulations.

Consultation of the Interested and Affected Parties (I & APs) is part of the EIA process for the proposed 2D seismic survey operations in line with the environmental regulatory requirements. Due to the specialised nature of the proposed project activities and situated in remote communal areas, the project team will focus heavily on working with the regional, local and traditional leaders who be responsible for informing their local communities about the proposed activities. Continuous consultation and updating of the political (Governors and local Councillors) and traditional leaders of the Kavango West and East Regions about the proposed activities shall continue to be undertaken to make sure that the local community are kept up to date on the ongoing activities and do not feel afraid if they happen to come across the exploration team in area.

4.7.2 Stakeholders Consultation Process to be Undertaken

Prior to the implementation of the public and stakeholder consultation processes as part of the formal project registration with the Government, a Draft Scoping Report with Terms of Reference for the EIA and EMP phases was prepared and submitted to the Environmental Commissioner in the Ministry of Environment, Forestry and Tourism through the Petroleum Commissioner in the Ministry of Mines and Energy. Public and stakeholder consultations process covering all the Interested and affected Parties (I&APs) was conducted during the months of January and February 2021. A total six (6) public notices were published in the local newspapers as follows:

6. Public notice for the extension of the dealing for submitting comments, inputs, or objections from Friday 29th February 2021 to Friday, 12th February 2021 that was published in the New Era Newspaper dated Monday, 8th February 2021.

Stakeholder and public meetings were organised with respect to the proposed 2D seismic survey operations in PEL 73.
Copy of the public notice first published in the New Era dated 7th January, the Namibian Newspaper dated Wednesday, 13th Confidente Newspaper dated 14th T 20th January, the Market Watch insert in the Republikein, Allgemeine Zeitung and Namibian Sun newspapers dated Friday, 15th and 18th January and the extension of the dealing published in the New Era Newspaper dated Monday, 8th February 2021.
5. EIA AND EMP TERMS OF REFERENCE (ToR)

5.1 Terms of Reference (ToR) Overview


Summary of the proposed activities, alternatives and key issues considered during the Environmental Assessment (EA) process are summarised in Table 5.1. The EIA and EMP process for the proposed 2D seismic survey operations shall be performed with reasonable skill, care and diligence in accordance with professional standards and practices existing at the date of performance of the assessment and that the guidelines, methods and techniques used and applied in this study conformed to the national regulatory requirements, process and specifications in Namibia and in particular as required by Ministry of Mines and Energy (MME), Ministry of Environment, Forestry, and Tourism (MEFT) and the client (Proponent). The preparation of the EIA and EMP reports was undertaken in line with the January 2015 MEFT Environmental Assessment Reporting Guideline.

5.2 Summary of EIA Approach and Methodology

5.2.1 Overview of the EIA Methodology

The Environmental Assessment process for this project has been undertaken in accordance with the applicable regulations and assessment procedures. The assessment process also took into considerations Reconnaissance Energy Namibia (Pty) Ltd corporate governance requirements as well as all other relevant Namibian laws, regional (Southern Africa Development Community î SADC) and international environmental and petroleum exploration protocols, standards, and practices applicable for onshore oil and gas well drilling operations.

The general framework of the baseline data collection was as follows:

- Scoping (determination of geographical and other boundaries; preliminary assessment).
- Review of existing regulatory framework and institutional arrangements.
- Local community and stakeholder mapping and pre-consultation for the local community and regional leadership.
- Public and stakeholder consultation process.
- Field verifications and detailed field-based environmental assessments.
- Reporting, impact identification and development of suggested mitigation measures, and.
- Reporting, development of an Environmental Management Plan (EMP) with roles and responsibilities.

Prior to the field study, a desktop studies were conducted to review the available reports, and to design plans and maps to compile relevant biophysical and socioeconomic information of the project area. Biophysical studies covered environmental aspects such as physiography, climate, hydrology, drainage, soils, geology/hydrogeology, vegetation, wildlife, and aquatic environment. The socioeconomic environmental study covered information on issues such as population, literacy, social amenities (healthcare and schools), land use, land tenure, the social dimensions of wellbeing and income levels, water supply, sanitation levels and security, along with other pertinent issues. The field-based study also used to validate the data compiled during the desktop study.
<table>
<thead>
<tr>
<th>PROPOSED 2D SEISMIC SURVEY PROJECT ACTIVITIES</th>
<th>ALTERNATIVES CONSIDERED</th>
<th>KEY ISSUES EVALUATED AND ASSESSED IN THE EIA REPORT WITH MITIGATION MEASURES PROVIDED IN THE ENVIRONMENTAL MANAGEMENT PLAN (EMP) REPORT</th>
</tr>
</thead>
</table>
| (i) Planning and mobilisation (Pre-survey preparation). | (i) Survey location with respect to the PEL and Area of Interest (AOI) | 1. Water quality  
2. Physical infrastructure and resources  
3. Air quality, noise, and dust  
4. Landscape and topography  
5. Soil quality  
6. Climate change influences. |
| (ii) Camp sites setups and widening of tracks and creation of limited new access as may be applicable. | (ii) Profiles / survey lines kms length and location | |
| (iii) Energy source (Vibroseis, Explorer 860 or Dynamite) | (iii) Energy source (Vibroseis, Explorer 860 or Dynamite) | |
| (iv) Actual data acquisition, and. | (iv) Receivers / Geophones (Wireless or Cabled) | |
| (v) Other alternative land, roads and tracks uses | (v) Other alternative land, roads and tracks uses | |
| (vi) Ecosystem Function (What the Ecosystem Does) | (vi) Ecosystem Function (What the Ecosystem Does) | |
| (vii) Ecosystem Services | (vii) Ecosystem Services | |
| (viii) Use Values | (viii) Use Values | |
| (ix) Non-Use, or Passive Use | (ix) Non-Use, or Passive Use | |
| (x) The No-Action Alternative | (x) The No-Action Alternative | |

5.2.2 Summary of the Environmental Assessment Process and Steps

The EIA and EMP process used for this project took into considerations the provisions of the Environmental Impact Assessment (EIA) Regulations, 2012 and the Environmental Management Act (EMA), 2007, (Act No. 7 of 2007) as outlined in Fig. 5.1. The environmental assessment steps undertaken or still to be taken are summarised as follows (Fig. 5.1):

1. Project screening process (Undertaken in November 2020).
(ii) Preparation of the Draft BID/Draft Scoping Report with Terms of Reference (ToR) for review by the Proponent (Undertaken in December 2020).

(iii) Preparation of the Public Notice published in the local newspapers as part of required public consultation process (Undertaken in December 2020).

(iv) Project registration / notification through the completion of the online formal registration / notification form on the MEFT online Portal (www.eia.met.gov.na), together with the hardcopies of the Draft BID/Scoping Report with ToR submitted to the Environmental Commissioner in the MEFT through the Ministry of Mines and Energy (MME) Director of Energy (Competent Authority) for review (Undertaken in January 2021).

(v) Opened the Stakeholder register (Undertaken in January 2021).

(vi) Invitation / notices to stakeholders and the general public to participate in environmental assessment process issued through the local newspaper advertisements as well as via direct emails communications to key stakeholders institutions such as Line Ministries, Regional and Local Governments as may be applicable (Undertaken in January-February 2021 for a period of 21 days from the 1st publication published on the 7th January 2021). Public consultation period was extended to the 12th February 2021.

(vii) Preparation of the Draft EIA and EMP Reports (Undertaken in February and March 2021).

(viii) Preparation of the Final EIA and EMP Reports (Undertaken in March 2021).

(ix) The final EIA and EMP reports submitted to the Environmental Commissioner in MEFT through the MME (Competent Authority) in fulfilment of all the requirements of the Environmental Impact Assessment (EIA) Regulations No. 30 of 2012 and the Environmental Management Act, (EMA), 2007, (Act No. 7 of 2007) for application of the Environmental Clearance Certificate (ECC) for the proposed project (March 2021).

(x) Following the submission of the application for ECC to the Environmental Commissioner, the public and stakeholders who are interested or affected by the proposed project given additional fourteen (14) days to submit comments / inputs about the proposed project direct to the Environmental Commissioner when the application is made available for additional comments / inputs by the Environmental Commissioner on the MEFT digital Portal www.eia.met.gov.na, and.

(xi) Wait for the Records of Decision (RD) from the Environmental Commissioner (From March 2021).

5.2.3 Assumptions and Limitations

The following assumptions and limitations underpin the approach adopted, overall outcomes and recommendations of the environmental assessment process and this EIA Report:

- The proposed 2D seismic Survey activities as well as all the plans, maps, PEL, Area of Interest, profiles / survey line boundary / coordinates, and appropriate data sets received from the Proponent, project partners, regulators, Competent Authorities, and specialist consultants are assumed to be current and valid at the time of conducting the studies and preparation of this EIA Report.

- The impact assessment outcomes, mitigation measures and recommendations provided in the EIA and EMP Reports are valid for the lifecycle or repeat of the proposed 2D seismic survey operations.
A precautionary approach has been adopted in instances where baseline information and impact assessment guidelines were insufficient or unavailable or site-specific project activities were not yet available, and.

Mandatory timeframes as provided for in the EIA Regulations No. 30 of 2012 and the EMA, 2007, (Act No. 7 of 2007) have been observed.

Figure 5.1: RBS Schematic presentation of Namibia’s Environmental Assessment Procedure.
Figure 5.2: Copy of the Public Notice published in the New Era Newspaper dated Thursday, 7th January 2021 marking the 1st day of the more than 21 days for public consultations for the proposed 2D seismic survey operations.
5.3 EIA and EMP Objectives, Assumptions, Alternatives and Receptors

5.3.1 Objectives of the EIA and EMP Phases

The aims and objectives of the Environmental Assessment (EA) covering the EIA and EMP to be prepared for the proposed 2D seismic survey operations over the areas of interest in PEL 73 are:

(i) To assess all the likely positive and negative short- and long-term impacts on the receiving environment (physical, biological, and socioeconomic environments) at local survey lines areas, regional (Kavango West and East Regions), national (Namibia) and Global levels using appropriate assessment guidelines, methods and techniques covering the complete project lifecycle.

(ii) To develop appropriate mitigation measures that will enhance the positive impacts and reduce the likely negative influences of the negative impacts identified or anticipated. Such mitigation measures are contained in a detailed EMP report covering the proposed 2D seismic survey, and, Operations.

(iii) To undertake the environmental assessment process and prepare EIA and EMP Reports with reasonable skill, care and diligence in accordance with professional standards and practices existing at the date of performance of the assessment and that the guidelines, methods and techniques that have been applied are all in conformity to the national regulatory requirements, process and specifications in Namibia as required by Ministry of Mines and Energy (MME), Ministry of Environment, Forestry and Tourism (MEFT), and.

(iv) Prepare the EIA and EMP Reports in line with the January 2015 MEFT Environmental Assessment Reporting Guidelines.

5.3.2 Proposed Project Alternatives and Ecosystem Assessments

The following alternatives have been considered as part of the Environmental Scoping study and reviewed and fully assessed during the EIA and EMP process with respect to the proposed 2D seismic survey operations:

(i) Survey location with respect to the PEL and Areas of Interest (AOI): The targeted areas of interest are site-specific and related to the regional and local geology and petroleum system of a specific area to which there are no alternatives sites to consider with respect to the license area. The only other alternative is the no-action option (no project activities are implemented).

(ii) Profiles / survey lines kms length, roads, and tracks to be used: The proposed 2D seismic survey operations will be undertaken along north-south and east west oriented existing roads and tracks. Several alternative roads and tracks have been identified and exists in the area. Alternatives to the proposed survey lines lengths are also possible along the existing selected and alternative roads and tracks and have been reviewed and assessed in the EIA Report.

(iii) Energy source (Vibroseis, Explorer 860 or Dynamite): Section 2.3.2 provides a details comparative assessment on the use of vibroseis, dynamite or Explorer 860 for the proposed 2D seismic operations in PEL 73. The Explorer 860 has been selected because it provides impressive peak force, excellent frequency content with high productivity and minimal environmental impact with a single unit per source point (3 units on project), 860,000 lbs. of adjustable force, faster than vibroseis, zero phase data same as dynamite, closest operating limits to infrastructure and perfect for high density population and environmentally sensitive areas, patented source technology, very fast 10 seconds between pops and typically 3-4 pops per Source Point (SP) and very high fold capability.

(iv) Receivers / Geophones (Wireless or Cabled): Latest wireless geophones / receivers / recorders will be used in the proposed 2D seismic survey instead of cabled old technology systems. The proposed survey will use the STRYDE recording technology which represents the latest, smallest, and most easily deployable system on the market with a wider lines offsets.
that does not require extensive vegetation clearing, scales to thousands of channels, flexibility to deploy over demanding terrains, higher productivity with no downtime for cable repairs, reduced crew and transportation costs, small footprint, improved safety, and reduced risk of injury.

(v) **The No-Action Alternative** - A comparative assessment of the environmental impacts of the no-action alternative (a future in which the proposed 2D seismic survey activities do not take place) has been undertaken. An assessment of the environmental impacts of a future, in which the proposed exploration and possible discovery of economic petroleum resources does not take place, may be good for the receiving environment because there be no any form of negative environmental impacts due to proposed exploration or possible petroleum production operations will take place in the area. The environmental benefits will include no negative environmental impacts on the receiving environment. However, it is important to understand that even if the proposed exploration activities do not take, to which the likely negative environmental impacts are likely to be low and localised, the current and other future land uses will still have some negative impacts on the receiving environment.

The likely negative environmental impacts of other current and future land use that may still happen in the absence of the proposed petroleum exploration activities includes: Land degradation due to drought, deforestation due to poor land management practices (slash and burn farming practices), timber harvesting, new communal land allocations, new homesteads and field clearing due increasing population, wild and manmade fires, erosion, and overgrazing. Furthermore, it is also important to understand what benefits might be lost if the proposed exploration activities do not take place. Key loses that may never be realised if the proposed project activities do not go-ahead include: Loss of potential added value to the unknown underground potential subsurface resources such as petroleum, minerals, water, other energy sources that may be found within the PEL No. 73 using the 2D seismic survey data to be generated, socioeconomic benefits derived from current and future exploration and possible petroleum production capital investments, current license rental fees, current contributions to training of Namibians, royalties payable to Government, direct and indirect contracts and employment opportunities, export earnings, foreign direct investments and various taxes payable to the Government of Namibia.

(vi) **Land Uses and Conflicts**: The proposed survey area falls within the sparsely populated communal land of the Kavango West and East Regions. Communal subsistence agricultural land uses area dominated by stock and seasonal crop farming practices. Several community forests exist in the area with existing roads and tracks cutting across these areas. Due to the limited scope of the proposed 2D seismic survey operations centred around the existing roads and tracks, it is likely that the proposed activities will coexist with the current land and future uses in the area.

(vii) **Ecosystem Function (What the Ecosystem Does)**: Ecosystem functions such as wildlife habitats, carbon cycling or the trapping of nutrients and characterised by the physical, chemical, and biological processes or attributes that contribute to the self-maintenance of an ecosystem in this area are vital components of the receiving environment. However, subject to the outcomes of the EIA, the proposed 2D seismic survey activities may not affect the ecosystem function due to the limited scope centred around the existing roads and tracks.

(viii) **Ecosystem Services**: Food chain, harvesting of animals or plants, and the provision of clean water or scenic views are some of the local ecosystem services associated with the proposed project area. However, subject to the outcomes of the EIA, the proposed 2D seismic survey activities may not affect the ecosystem function due to the limited scope centred around the existing roads and tracks.

(ix) **Use Values**: The proposed project area has direct values for other land uses such as agriculture, conservation, and tourism as well as indirect values which includes: Watching a television show about the general area and its wildlife, food chain linkages that sustains the complex life within this area and bequest value for future generations to enjoy. Subject to the
outcomes of the EIA, the proposed 2D seismic survey activities will not destroy the current use values because the activities will be centred around the existing roads and tracks, and.

(x) Non-Use or Passive Use: The proposed project area has an existence value that is not linked to the direct use / benefits to current or future generations. Subject to the outcomes of the EIA, proposed 2D seismic survey operations will not affect the ecosystem current or future none or passive uses due to the scope of the proposed activities that might leave much of the project area untouched because the activities will be centred around the existing roads and tracks targeting potential deep-seated (averaging 4 km) subsurface geological structures.

5.4 Summary of the Likely Positive and Negative Impacts

5.4.1 Summary of Likely Positive Impacts

The proposed 2D seismic survey operations covering the areas of interest in PEL No. 73 will have greater positive impacts in terms of monetary contributions to the central government (Ministry of Mines and Energy) revenue pool as well as contribute great to the knowledge and understanding of the petroleum systems of the newly discovered Kavango Basin. The following is the summary of the key positive impacts:

× Increased earnings to the State Revenue through rental fees as well as contributions to the training fund held by National Petroleum Corporation of Namibia, NAMCOR.

× Increased temporal contracts and employment opportunities for local services providers and local revenue circulation from ancillary (industrial support) service demands.

× Improved rural infrastructure services such clearing of poorly accessible tracks.

× Demand for some public services may increase.

× Unemployment may decrease.

× Utility payment increase and infrastructure may be expanded, and.

× Improved knowledge on other potential subsurface natural resources that may be associated with the area such water, minerals, and geothermal resources.

Overall, the proposed development will temporarily but significantly contribute to the rural local economic activities and a catalyst for local growth through capital injection and various taxes that will be payable.

5.4.2 Summary of Receptors Likely to be Negative Impacted

5.4.2.1 Vibration, Noise and Dust (Air Quality)

The following are possible sources of vibrations, air and dust pollution that evaluated and assessed further during the EIA and EMP process:

(i) Vibrations and noise:

× Survey equipment: There will be noise generated from survey equipment and light vehicles.

× Project infrastructure: Due to the unpaved road even though in good condition, vehicular activity will increase which may influence the local environment, and.

× Fly campsite: Construction of the fly camp facilities may increase ambient noise.

(ii) Air quality:
× Survey equipment: Survey equipment and light vehicle will all generate small volumes of dust especially during the dry season.

× Project infrastructure: Air quality (dust) will deteriorate because of increased volume of vehicular activities during survey operation from the roads (unpaved) and tracks though in good conditions, and.

× Burning of fuels fumes will contribute to the localised small percentage to air quality deterioration.

5.4.2.2 Fauna and Flora Receptors

The proposed 2D ground seismic survey lines /profiles have been positioned along existing roads and tracks or already cleared areas / fields. Only minimum widening of existing tracks may be necessary in some places in order for the survey vehicles to pass easily. The fly camp site will be situated on an area which is already cleared including the use of the already existing facilities in Rundu and current drilling locations. No vegetation will be removed for the temporary campsite and no big trees will be removed along existing tracks.

The proposed survey area and areas of interest are not part of the habitats known to be associated with the free roaming northern and north-eastern Namibian heads of elephants that migrates between Kaudum and Mangetti National Parks as claimed by those who do not know the areas of interest, the local habitat areas and never been in the field to familiarised themselves with the field-based conditions. Elephant are known to use infrasound communication with frequencies from 14-35 Hz for long distance communication with the best period for such communication just after sunset when night-time cooling enhances low-frequency sounds and thus maximises communication ranges (Garstang et al. 1995). Furthermore, elephant also use seismic communication i.e. ground borne stimuli which works better in sandy soils to avoid or threaten predators, assess and navigate within the environment, and communicate (O'Connell-Rodwell 2007, O'Connell-Rodwell et al. 2007).

However, elephants are not sedentary in the proposed development area and mainly located to the east, in the Kaudum National Park with occasional movements to the west and south, between Kaudum and Mangetti National Parks and north-east between the Kaudum National Park and Mahangu Core Area. The seismic surveys will be executed to the north and west of most elephant activities as well as be conducted only during daylight hours along existing roads and tracks. The proposed survey operations covering the key exploration Areas of Interest (AOI) within PEL 73 will be conducted using the Explorer 860 Accelerated Weight Drop (AWD) energy sources and wireless receivers for better line offsets. The “weight-drop” which generates a thump as it hits the ground will have an impulse frequency of 300 Hz and not expected to have any frequency specific interference with the natural receiving environment.

2D seismic survey operations using heavy Vibroseis trucks were successfully undertaken in Kavango West in 2018 without any impact on the local fauna or flora. Despite the fact that the proposed 2D seismic survey operations will be undertaken along existing roads and tracks, field-based fauna and flora specialist assessment have been undertaken as part of the EIA and EMP process to have a broader understanding of the local fauna and flora diversity of the local area.

5.4.2.3 Protection of Water Resources

The primary risk of contamination of soils, surface waters and aquifers, is from the fuel leakages as well as emissions from the fly camp sites. Although the risk of such contamination is highly localised, it has the potential to impact the local areas. Therefore, the 2D seismic survey operations should remain under strict surveillance along the survey lines and at the camp site. However, the proposed 2D seismic survey lines will be undertaken along existing roads and tracks and the camp sites locations will be situated in already disturbed areas and will also use existing facilities as far as possible all to be situated far away from ephemeral river channels or groundwater recharge zones. Overall, the proposed survey area does not fall within the ground water protected area or highly vulnerable groundwater pollutions zones as shown in Fig. 5.3.
5.4.2.4 Archaeology

In addition to archaeological heritage, modern heritage of Kavango West and East Regions is characterized by remnants of numerous historic, sacred cultural sites as well as present-day community graves and cemeteries that are to be avoided. Earliest archaeological heritage is attributed to the Late Iron Age settlements, restricted along the Okavango River basin. This industry is evidenced by numerous archaeological artefacts including but not limited to ceramics (decorated & undecorated), small number of imported glass trade beads, some stone artefacts, worked ostrich eggshells and iron implements.

However, the proposed 2D seismic survey lines to be undertaken along the existing roads and tracks will not likely affect local archaeological resources although existing disturbance of the areas through previous land-use system and existing infrastructure development activities would or might have probably already compromised some of the sites if existed.
Due to their established significance, the identified archaeological sites within the survey area must still be treated as "no go zones" and no disturbances should occur given their vulnerability nature and sensitivities. It is hereby recommended that an assessment review of the identified archaeological sites by a specialist be considered as part of EIA with respect to the proposed 2D seismic survey operations.

5.4.2.5 Socioeconomic Components

Socioeconomic impacts of the proposed project activities are likely to be minimal and tend to be positive. A clear understanding of these impacts may help communities understand and anticipate the effects of the proposed 2D seismic survey. One of the major possible impacts may be unrealistic job expectations about the proposed project. It is important for local communities to bear in mind that the proposed project activities will be temporary over a period of 3-4 months. The limited but temporary job opportunities will mainly be available for the debushing / widening of some of the areas along the survey lines, logistics and geophones deployment and recovery operations. The limited number of people that will temporarily be part of the survey team will not affect the social and cultural settings of the sparsely populated survey areas along the proposed survey lines.

Recruitment shall be highly localised, targeting local communities along each survey line in order to distribute the positive social economic benefits as wider as possible over the survey area. The EIA process combined with the field-based stakeholder mapping, consultation and engagement processes assessed the broader socioeconomic aspects of the proposed 2D seismic survey and recommends mitigation measures in the EMP that will enhance the temporary socioeconomic benefits that the proposed 2D seismic survey may offer to the local communities.

5.4.2.6 Waste Management

Although very limited for a very short period of time, various types of wastes (liquids and solids) are likely to be generated mainly around the proposed campsite and along the survey lines/profiles. The campsite will be equipped to handle both the liquid and solid waste likely to be generated. The campsite will be equipped with chemical toilets for the management of waste water with mobile toilets made available along the profiles/survey lines. Waste bags for management of solid waste will be made available at the campsite and will also be carried along the survey lines and no litter shall be tolerated. Burial of solid waste around the campsite, along the survey lines or anywhere within or outside the PEL area is prohibited. All solid waste collected at the campsite and along the survey lines/profiles will only be disposed at an approved municipal facility at Rundu. Continuous debriefing and awareness of the survey team on all matters related to environmental management shall be undertaken.

5.4.3 Stakeholder Consultation Process

5.4.3.1 List of Potential Stakeholders

Risk-Based Solutions has identified the following stakeholder groups with respect to the proposed 2D seismic survey operation in PEL 73 as summarised in Table 5.2.:

(i) Central Government (Key line Ministries).
(ii) Regional Councils in Kavango West and East Regions.
(iii) Constituency Councillors in Kavango West and East Regions.
(iv) Traditional / Tribal Authorities in Kavango West and East Regions.
(v) Local communities.
(vi) Project personnel, and.
(vii) NGOs and conservation organisations
Table 5.2: List of stakeholder groups identified.

<table>
<thead>
<tr>
<th>ENGAGEMENT METHOD</th>
<th>MOST APPROPRIATE PUBLIC / STAKEHOLDER ENGAGEMENT ACTIVITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Print media / Newspaper advertisement / notices / Articles</td>
<td>✗ Published advertisements / notices / articles in local newspapers about the proposed project and consultation activities being undertaken</td>
</tr>
<tr>
<td>Social media</td>
<td>✗ Facebook, twitter, WhatsApp, and other media platforms were used to inform and distribute information to key stakeholders</td>
</tr>
<tr>
<td>Correspondence by formal letters phone/email/Text/Instant messaging/ Voice or Video Conferencing/ Information Seminars</td>
<td>✗ Distribute project information to government officials, organisations, agencies and companies</td>
</tr>
<tr>
<td></td>
<td>✗ Invited stakeholders to meetings</td>
</tr>
<tr>
<td>Radio announcements</td>
<td>✗ Disseminate project information to large audiences, and rural stakeholders though the offices of the regional councils, councillors and traditional authorities</td>
</tr>
<tr>
<td></td>
<td>✗ Inform stakeholders about consultation meetings</td>
</tr>
<tr>
<td>One-on-one interviews</td>
<td>✗ Solicit views and opinions</td>
</tr>
<tr>
<td></td>
<td>✗ Enable stakeholders to speak freely and confidentially about controversial and sensitive issues</td>
</tr>
<tr>
<td></td>
<td>✗ Build personal relations with stakeholders especially community influencers</td>
</tr>
<tr>
<td></td>
<td>✗ Recording of interviews</td>
</tr>
<tr>
<td>Formal / Informal poster / meetings session</td>
<td>✗ Presented project information to groups of stakeholders</td>
</tr>
<tr>
<td></td>
<td>✗ Facilitated meetings using PowerPoint presentations, posters, models, videos and pamphlets and project information documents</td>
</tr>
<tr>
<td></td>
<td>✗ Allowed the group of stakeholders to provide their views and opinions</td>
</tr>
<tr>
<td></td>
<td>✗ Build impersonal relations with high level stakeholders</td>
</tr>
<tr>
<td></td>
<td>✗ Distributed technical documents</td>
</tr>
<tr>
<td></td>
<td>✗ Record discussions, comments/questions raised and responses</td>
</tr>
<tr>
<td>Public meetings</td>
<td>✗ Present project information to a large audience of stakeholders, and in particular communities / town halls / open village tree settings</td>
</tr>
<tr>
<td></td>
<td>✗ Allow the group of stakeholders to provide their views and opinions</td>
</tr>
<tr>
<td></td>
<td>✗ Build relationships with neighbouring communities</td>
</tr>
<tr>
<td></td>
<td>✗ Distribute non-technical project information</td>
</tr>
<tr>
<td></td>
<td>✗ Facilitate meetings using PowerPoint presentations, posters, models, videos and pamphlets or project information documents</td>
</tr>
<tr>
<td></td>
<td>✗ Record discussions, comments/questions raised and responses</td>
</tr>
</tbody>
</table>

5.4.3.2 Selection of the Appropriate Consultation Method

All consultation processes were conducted on the basis of culturally acceptable and appropriate delivery methods for each of the different stakeholder groups and the following are the key examples of the consultation methods that were used:

✗ Prepared formal project specific information dissemination presentations when consulted government (Central, Regional or Local Authority) officials.

✗ When dealing with communities, targeted meetings with a mixture of the use of posters, handouts leaflets, videos and formal interactive simple physical visual examples that allowed the participants to contribute and participate in the discussion, and.

✗ When working with an informal focus group discussion this was facilitated by PowerPoint presentations, posters, non-technical pamphlets and other visual materials.

There are a variety of engagement techniques used to build relationships with stakeholders, gather information from stakeholders, consult with stakeholders, and disseminate project information to stakeholders. When selecting an appropriate consultation technique, culturally appropriate consultation
methods, and the purpose for engaging with a stakeholder group were considered. Table 5.3 provides a detailed assessment of the engagement methods that were adopted as applicable.

Table 5.3: Assessment of potential appropriate engagement method and associated activities.

<table>
<thead>
<tr>
<th>ENGAGEMENT METHOD</th>
<th>MOST APPROPRIATE PUBLIC / STAKEHOLDER ENGAGEMENT ACTIVITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Print media / Newspaper advertisement / notices / Articles</td>
<td>✗ Published advertisements / notices / articles in local newspapers about the proposed project and consultation activities being undertaken</td>
</tr>
<tr>
<td>Social media</td>
<td>✗ Facebook, twitter, WhatsApp, and other media platforms were used to inform and distribute information to key stakeholders</td>
</tr>
<tr>
<td>Correspondence by formal letters phone /email/Text/Instant messaging/ Voice or Video Conferencing/ Information Seminars</td>
<td>✗ Distribute project information to government officials, organisations, agencies and companies ✗ Invited stakeholders to meetings</td>
</tr>
<tr>
<td>Radio announcements</td>
<td>✗ Disseminate project information to large audiences, and rural stakeholders through the offices of the regional councils, councillors and traditional authorities ✗ Inform stakeholders about consultation meetings</td>
</tr>
<tr>
<td>One-on-one interviews</td>
<td>✗ Solicit views and opinions ✗ Enable stakeholders to speak freely and confidentially about controversial and sensitive issues ✗ Build personal relations with stakeholders especially community influencers ✗ Recording of interviews</td>
</tr>
<tr>
<td>Formal / Informal poster meetings session</td>
<td>✗ Presented project information to groups of stakeholders ✗ Facilitated meetings using PowerPoint presentations, posters, models, videos and pamphlets and project information documents ✗ Allowed the group of stakeholders to provide their views and opinions ✗ Build impersonal relations with high level stakeholders ✗ Distributed technical documents ✗ Record discussions, comments/questions raised and responses</td>
</tr>
<tr>
<td>Public meetings</td>
<td>✗ Present project information to a large audience of stakeholders, and in particular communities / town halls / open village tree settings ✗ Allow the group of stakeholders to provide their views and opinions ✗ Build relationships with neighbouring communities ✗ Distribute non-technical project information ✗ Facilitate meetings using PowerPoint presentations, posters, models, videos and pamphlets or project information documents ✗ Record discussions, comments/questions raised and responses</td>
</tr>
<tr>
<td>Focus group meetings</td>
<td>✗ Allow a smaller group of between 8 and 15 people to provide their views and opinions of targeted baseline information ✗ Build relationships with neighbouring communities ✗ Use a focus group interview guideline to facilitate discussions ✗ Record responses</td>
</tr>
<tr>
<td>Surveys</td>
<td>✗ Gather opinions and views from individual stakeholders ✗ Gather baseline data ✗ Record data ✗ Develop a baseline database for monitoring impacts</td>
</tr>
</tbody>
</table>

5.4.3.3 Stakeholder Engagement Schedule

Stakeholder engagement is important throughout the lifecycle of the proposed project 2D seismic survey operations. In accordance with the provisions of the EIA Regulations, 2012, the following is summary of key phases of the required stakeholders consultations and engagement processes:

(i) Pre-survey scouting to assess accessibility and confirm the line survey scouting to be included in the EIA Process undertaken during the month of December 2020 and January 2021.
EIA and EMP regulatory permitting process undertaken in January and February 2021.

Planning and mobilisation (Tracks / roads preparation (narrow tracks widening) to be undertaken before implementation in 2021.

Data acquisition (Actual Survey) to be undertaken before implementation in 2021, and.

Demobilisation and survey completion to be undertaken before implementation in 2021.

### 5.4.3.4 EIA and EMP Public and Stakeholder Consultation Meetings Schedule

The following public meetings and open days sessions were organised as part of the stakeholder and public consultation process for the proposed 2D seismic survey operations in PEL 73:

(i) Kavango West Region, Nkurenkuru, Nkurenkuru Community Hall, Wednesday, 20th January 2021, Morning Session from 10hrs00 to 13hrs00 Formal Meeting and Afternoon Session from 15hrs00 to 18hrs00 Open Sessions Public walk in as needed.

(ii) Kavango East Region, Rundu, AMTA, Friday 22nd January 2021, Morning Session from 10hrs00 to 13hrs00 Formal Meeting and Afternoon Session from 15hrs00 to 18hrs00 Open Sessions Public walk in, and.

(iii) Khomas Region, Windhoek, Hotel Thule, 2nd February 2021, Morning Session from 10hrs00 to 13hrs00 Formal Meeting and Afternoon Session from 14hrs00 to 16hrs00 Formal Meeting organised by ReconAfrica and Namibia Chamber of Environment (NEC), and.

(iv) Field-based public / local villages community meetings and poster sessions at the following key settlements situated along the various seismic survey lines: Sivaradi 1 and 2, Gcaru, Ncuncuni, Ncaute, Makandina,Mutwegombahe, Mmbambi and Cuma in Kavngo West and East Regions as well as the San Community at Omega 1, covering Omega 1, Chetta, Mangarangandja, Mutjiku, Mushashani and at Mshasho Villages and Masambo Community, covering Masambo, Poca, Omega 3, Chetto, Muteik, Pipo and Ionxei villages in Bwabwata National Park, Western Zambezi Region. The field-based meetings / sessions were undertaken in coordination with the regional councillors and traditional authorities from 23rd January 2021 to the 8th March 2021.

Details of the meetings undertaken are provided in Annex 3 of the EIA Report. Additionally, the prepared environmental reports to be submitted to the Environmental Commissioner will be subjected to further public consultation and disclosure by the Environmental Commissioner for a period of fourteen (14) days. All registered stakeholders will be informed once the environmental reports are available at www.eia.met.gov.na.

### 5.5 Proposed EIA Assessment of Likely Impacts

#### 5.5.1 Overview

The overall impact assessment adopted the Leopold matrix framework which is one of the internationally best-known matrix assessment methodology available for predicting the impact of a project on the receiving environment.

The assessment process took into considerations the proposed activities, trade-offs, alternatives, and issues to be considered as outlined in Table 1.1. Further inputs were provided by specialist consultants.
5.5.2 Severity Criteria for Environmental Impacts

In evaluating the severity of potential environmental impacts likely to be associated with the proposed 2D seismic survey operations, the following factors has been taken into consideration:

- Receptor/ Resource Characteristics: The nature, importance and sensitivity to change of the receptors / target or resources that could be affected.
- Impact Magnitude: The magnitude of the change that is induced.
- Impact Duration: The time period over which the impact is expected to last.
- Impact Extent: The geographical extent of the induced change, and.
- Impact Severity: The severity of an impact is a function of a range of considerations.
- Likelihood of Occurrence (Probability): How likely is the impact to occur? and.
- Regulations, Standards and Guidelines: The status of the impact in relation to regulations (eg. discharge limits), standards (eg. environmental quality criteria) and guidelines.

The overall impact severity has been categorised using a subjective scale as shown in Table 5.4 for magnitude, Table 5.5 for duration and Table 5.6 for extent.

Table 5.4: Scored on a scale from 0 to 5 for impact magnitude.

<table>
<thead>
<tr>
<th>SCALE (-) or (+)</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>no observable effect</td>
</tr>
<tr>
<td>1</td>
<td>low effect</td>
</tr>
<tr>
<td>2</td>
<td>tolerable effect</td>
</tr>
<tr>
<td>3</td>
<td>medium high effect</td>
</tr>
<tr>
<td>4</td>
<td>high effect</td>
</tr>
<tr>
<td>5</td>
<td>very high effect (devastation)</td>
</tr>
</tbody>
</table>

Table 5.5: Scored time period over which the impact is expected to last.

<table>
<thead>
<tr>
<th>SCALE (-) or (+)</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>Temporary</td>
</tr>
<tr>
<td>P</td>
<td>Permanent</td>
</tr>
</tbody>
</table>

Table 5.6: Scored geographical extent of the induced change.

<table>
<thead>
<tr>
<th>SCALE (-) or (+)</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>limited impact on location</td>
</tr>
<tr>
<td>O</td>
<td>impact of importance for municipality.</td>
</tr>
<tr>
<td>R</td>
<td>impact of regional character</td>
</tr>
<tr>
<td>N</td>
<td>impact of national character</td>
</tr>
<tr>
<td>M</td>
<td>impact of cross-border character</td>
</tr>
</tbody>
</table>

The likelihood (probability) of the pre-identified events occurring has been ascribed using a qualitative scale of probability categories (in increasing order of likelihood) as shown in Table 5.7. Likelihood is estimated on the basis of experience and/ or evidence that such an outcome has previously occurred. Impacts resulting from routine/planned events are classified under category (E).
Table 5.7: Summary of the qualitative scale of probability categories (in increasing order of likelihood).

<table>
<thead>
<tr>
<th>SCALE (-) or (+)</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Extremely unlikely (e.g. never heard of in the industry)</td>
</tr>
<tr>
<td>B</td>
<td>Unlikely (e.g. heard of in the industry but considered unlikely)</td>
</tr>
<tr>
<td>C</td>
<td>Low likelihood (e.g. such incidents/impacts have occurred but are uncommon)</td>
</tr>
<tr>
<td>D</td>
<td>Medium likelihood (e.g. such incidents/impacts occur several times per year within the industry)</td>
</tr>
<tr>
<td>E</td>
<td>High likelihood (e.g. such incidents/impacts occur several times per year at each location where such works are undertaken)</td>
</tr>
</tbody>
</table>

5.5.3 Evaluation of Project Activities Impacts

The impact assessment and evaluation process has been based on considering the proposed 2D seismic survey operations as the source of impact. The receiving environment has been considered as the receptor/target that may be impacted positively or negatively by the activities of the proposed 2D seismic survey operations. The components of the receiving environment encompassed the following:

- Physical Conditions / Natural Environment: Air, noise, water, green space, climate change, built environment houses, roads, transport systems, buildings, infrastructure, etc.

- Biological Conditions: fauna, flora, habitats, and ecosystem - services, function, use values and non-use etc., and.

- Socioeconomic Conditions: Social, economic, labour, gender, human rights, natural and social capital, archaeological, cultural resources, and cultural issues

In evaluating the degree of potential negative impacts, the following factors have been taken into consideration:

- Impact Severity: The severity of an impact is a function of a range of considerations, and.

- Likelihood of Occurrence (Probability): How likely is the impact to occur?

The overall impact severity with respect to the impact duration, geographical extent and probability occurrence have been categorised using a semi quantitative approach and presented as shown in Table 5.8.
Table 5.8: Impact assessment matrix used for assessing the overall likely impacts that the proposed 2D seismic survey activities on the receiving environment sensitivity (physical, biological, socioeconomic, cultural, and archaeological environments) with respect to duration, geographical extent, and probability occurrence.

<table>
<thead>
<tr>
<th>RECEIVING ENVIRONMENT SENSITIVITY</th>
<th>PHYSICAL ENVIRONMENT</th>
<th>BIOLOGICAL ENVIRONMENT</th>
<th>SOCIOECONOMIC, CULTURAL, AND ARCHAEOLOGICAL ENVIRONMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SENSITIVITY RATING</strong></td>
<td><strong>CRITERIA</strong></td>
<td><strong>FATIGUE</strong></td>
<td><strong>FATIGUE</strong></td>
</tr>
<tr>
<td>1</td>
<td>Negligible</td>
<td>The receptor or resource is resistant to change or is of little environmental value</td>
<td>Water Quality</td>
</tr>
<tr>
<td>2</td>
<td>Low</td>
<td>The receptor or resource has the capacity to absorb change without fundamental altering its present character, is of high environmental or social economic or cultural importance</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Medium</td>
<td>The receptor or resource has moderate capacity to absorb change without significantly altering its present character, has some environmental or social economic or cultural importance</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>High</td>
<td>The receptor or resource has limited capacity to absorb change, without significantly altering its present character, is of very high environmental or social economic or cultural importance</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Very High</td>
<td>The receptor or resource has no capacity to absorb change</td>
<td></td>
</tr>
</tbody>
</table>

**SOURCES OF POTENTIAL IMPACT**

1. Planning and mobilisation (Pre-survey preparation)
2. Camp sites setups and widening of tracks and creation of limited new access as may be applicable
3. Actual data acquisition along the individual profiles / survey lines
4. Demobilisation and Closure (Survey Completion)
5. Any accidental event that may be associated with the routine and physical presence operational activities
5.5.4 Assessment of the Overall Significant Impacts

5.5.4.1 Overview

The determination of the significance of the negative impacts / key issues caused by the proposed 2D seismic survey activities as key sources of such impact has been based on the environmental baseline results and the intensity of the likely negative impact. The assessment focused on the degree to which the proposed project activities are likely to results in unwanted consequences on the receptor covering the receiving environment (natural, built, socioeconomic, flora, fauna, habitat, and ecosystem).

5.5.4.2 Summary of the Sources of Impacts

The main key sources of impacts that have been used in the determination of the significant impacts / key issues posed by the proposed 2D seismic survey activities covering the planning and mobilisation (Pre-survey preparation), camp sites setups and widening of tracks and creation of limited new access as may be applicable, actual data acquisition along the individual profiles / survey lines, demobilisation and closure (Survey completion) and any accidental event that may be associated with the routine and physical presence operational activities. Each of the main sources of impacts have been evaluated against the receiving environment as potential receptors with respect to potential pathways.

5.5.4.3 Determination of the Overall Likely Significant Impacts

To determine the overall significant impact for each individual source associated with the proposed 2D seismic survey activities, an impact identification and assessment process has been undertaken as part of the EIA.

The EIA impact identification and assessment processes focused on the environment interaction approach with respect to the proposed 2D seismic survey activities, alternatives and the likely targets or receptor / key issues linked to a specific pathway.

The results of the overall significant impacts assessment associated with the proposed 2D seismic survey activities / sources of potential impacts of significant impacts with respect to the receiving environment that could potentially be affected, resulting in key issues are presented in as shown in Table 5.9.
**Table 5.9:** Assessment matrix used for assessing the likely significant impacts with respect to proposed 2D seismic survey activities on the receiving environment (physical, biological, socioeconomic, cultural, and archaeological environments).

<table>
<thead>
<tr>
<th>Impact SEVERITY</th>
<th>PHYSICAL ENVIRONMENT</th>
<th>BIOLOGICAL ENVIRONMENT</th>
<th>SOCIOECONOMIC, CULTURAL, AND ARCHAEOLOGICAL ENVIRONMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very High (5)</td>
<td>Moderate [3-5]</td>
<td>Moderate [2-6]</td>
<td>Ecosystem functions, services, use values and non-use or passive use</td>
</tr>
<tr>
<td>Medium (3)</td>
<td>Minor [1-3]</td>
<td>Minor [1-3]</td>
<td>Ecosystem functions, services, use values and non-use or passive use</td>
</tr>
<tr>
<td>Low (2)</td>
<td>Minor [4-5]</td>
<td>None [0]</td>
<td>Ecosystem functions, services, use values and non-use or passive use</td>
</tr>
<tr>
<td>Negligible (1)</td>
<td>Minor [5-1]</td>
<td>None [0]</td>
<td>Ecosystem functions, services, use values and non-use or passive use</td>
</tr>
</tbody>
</table>

**SOURCES OF POTENTIAL IMPACT**

1. Planning and mobilisation (Pre-survey preparation)
2. Camp sites setups and widening of tracks and creation of limited new access as may be applicable
3. Actual data acquisition along the individual profiles / survey lines
4. Demobilisation and closure (Survey Closure)
5. Any accidental event that may be associated with the routine and physical presence operational activities
5.6 EIA and EMP Reporting

5.6.1 Overview

This detailed Environmental Scoping Report with Terms of Reference (ToR) has been prepared for the proposed 2D seismic survey operations over the areas of intertest in PEL 73. The Environmental Scoping Report has been followed by the EIA and EMP Reports that will support the application for Environmental Clearance Certificate (ECC) for the proposed 2D seismic survey operations.

5.6.2 EIA Reporting

The EIA Report provided an assessment of both positive and negative impacts likely to be associated with the proposed 2D seismic survey operations. Potential receiving environmental (physical, biological and socioeconomic) effects have been assessed in relation to the baseline conditions, i.e. the conditions that would prevail should the proposed 2D seismic survey operations not proceed. For the purpose of this assessment, receptors are defined as elements of the natural or human environment which may interact with, or be interacted by, the proposed project activities. Baseline conditions are those that existed at the time of the assessment. It is recognised that some receptors and resources may be more vulnerable to change or to have greater importance than others. Within the project areas of influences importance and sensitivity of receptors (physical, biological and socioeconomic) have been determined based on professional judgement and considering the following:

- Relevant legislative or policy standards or guidelines.
- Relative importance/value assigned to existing social or environmental features and receptors.
- Capacity of the receptor to absorb change, and.
- Capacity of the receptor to recover from change.

The following specialist studies considered as part of the EIA Process:

- Field-based fauna and flora assessment, and.
- Specialist inputs to the EIA sections of the reports covering socioeconomic archaeological, vibrations, dust, and noise reports and other as may be proposed by stakeholders during the consultation process.

5.6.3 EMP Reporting

5.6.3.1 Overview

The following approach has used regarding the need for mitigation measures on the assessed key issues to be actively addressed in the EMP Report and to be implemented and monitored by the Proponent:

- If environmental aspects are evaluated to be of low significance, they do not require specific management plans, and need not be actively addressed in the EMP (although they may still be listed and reported on).
- A decision on the need to actively address any issue with a "Medium" significance ranking will require consideration of other relevant factors, such as the nature of the impact, risks associated with possible cumulative aspects, and the degree of concern of stakeholders, and.
- If environmental aspects receive a "High" significance ranking, they must be addressed by means of active management, mitigation or rehabilitation measures.

For each negative impact of high or medium significance, mitigation objectives have been set (i.e. ways of reducing negative impacts), and attainable management actions subsequently addressed in the EMP
Report for the proposed 2D seismic survey operations. Without management, these impacts would either breach statutory limits or be unacceptable to statutory authorities or to stakeholders, as they would result in a significant deterioration of one or more environmental resources or components.

5.6.3.2 Hierarchy of Mitigation Measures Implementation

The overall outcomes of the environmental assessment process have been the preparation of the mitigation measures detailed in the EMP Report. A hierarchy of methods for mitigating significant adverse effects adopted for this environmental assessment and in order of preference are as follows:

(i) Enhancement, e.g. provision of new habitats.
(ii) Avoidance, e.g. sensitive design to avoid effects on ecological receptors.
(iii) Reduction, e.g. limitation of effects on receptors through design changes.
(iv) Compensation, e.g. community or environmental benefits.

The EMP provided detailed actions of the mitigation measures for minimising and maximising the identified negative and positive impacts respectively. The EMP provided the management actions with roles and responsibilities requirements for implementation of environmental management strategies by the Proponent.

5.6.3.3 General Mitigation Measures Implementation

The EMP provided a detailed plan of actions required in the implementation of the mitigation measures for minimising and maximising the identified negative and positive impacts respectively. The EMP also provided the management actions with roles and responsibilities requirements for implementation of environmental management strategies by the Proponent through the Contractors and Subcontractors who will be undertaking the proposed 2D seismic survey operations. The EMP recommended commitments including financial and human resources provisions for effective management of the likely environmental liabilities during and after the implementation of the proposed 2D seismic surveys. Based on the findings of this Scoping work, the following is the summary list of the key general mitigation measures reviewed and elaborated during the preparation of the EMP Report and to be implemented by the Proponent:

1. Project planning and implementation.
2. Implementation of the EMP, roles and responsibilities with resources allocation.
3. Management of public and stakeholders relations and continuous community engagements.
4. Measures to enhance positive socioeconomic impacts.
5. Environmental awareness briefing and training.
6. Erection of infrastructure to support the proposed 2D seismic survey.
7. Use of existing access roads, tracks, and general vehicle movements with respect to flora, habitat protection.
8. Specific mitigation measures for preventing flora and ecosystem destruction and promotion of conservation.
9. Specific mitigation measures for preventing faunal and ecosystem destruction and promotion of conservation.
10. Mitigation measures to be implemented for the preservation of the receiving environment through effective environmental management practices.
11. Mitigation measures for protection of surface and groundwater and water supply infrastructure protection.

12. Mitigation measures to minimise negative socioeconomic impacts.

13. Mitigation measures to always minimise negative health and safety impacts.

14. Mitigation measures to minimise visual impacts.

15. Management of sites and surrounding traffic and equipment movements.


17. Management of dust and influence on air quality / health receiving environment.

18. Spillages and accidental products or fuel leaks.

19. Mitigation measures for waste (solid and liquid) management.

20. Rehabilitation plan, and.


5.6.3.4 EMP Roles and Responsibilities

Within the framework of the EMP, the Proponent shall provide for a corporate structure for the management of the environmental elements that may be affected by the different activities of the proposed 2D seismic survey operations. The EMP also identified monitoring activities groups / environmental elements, the aspects / targets, the indicators, the schedule for implementation and who should be responsible for the management to prevent major impacts that the proposed 2D seismic survey activities may have on the receiving environment (physical and biological environments). It is highly imperative that there is an effective and response organisational structure of the Proponent defining the roles, responsibilities, and authority to implement the provisions of the EMP. An indicative summary of such a structure defined during the EMP implementation process is shown in Fig. 5.4.

![Diagram of organisational structure](image-url)
6. SCOPING CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary of Conclusions

All human induced activities including the proposed 2D seismic survey operations, have the potential to cause negative consequences on the receiving physical, biological, socioeconomic, cultural, and archaeological environments. By identifying the most important sensitivity components of the receiving environment including high risk habitats beforehand, coupled with environmentally acceptable recommendations (mitigating factors), will lessen the overall negative impacts and improves the positive impacts of such proposed project activities.

Based on the findings of this Environmental Scoping report, the EIA and EMP reports have been prepared to support the application for ECC for the proposed 2D seismic survey operations over the areas of interest within PEL 73. The EIA and EMP cover the whole proposed 2D seismic survey line coverages.

6.2 Summary of Recommendations

6.2.1 Key Terms of Reference (TOR) Issues

In meeting national regulatory the EA process covering this Scoping, EIA and EMP for the proposed 2D seismic survey operations addressed the following as key issues to be elaborated in detail in the EIA and EMP Reports and to be considered with respect to the receiving environment:

1. Disruption / disturbance of the habitats.
2. Reptiles.
3. Amphibian.
5. Avian.
6. Tree and shrub species.
7. Grass.
8. Socioeconomic environment.
10. Ecosystem functions, services, use values and non-use or passive use.
11. Physiography and geology.
13. Surface and groundwater quality.
14. Increased water consumption / depletion of water resources.
15. Existing local community water supply infrastructure along the proposed survey lines (existing roads and tracks).
17. Noise and vibrations.
18. Dust and air quality.

19. Waste (solid and liquid) management.

20. Accidental events.

21. Archaeological, paleontological, and historical resources.

22. Contributions to global Climate Change, and.

23. Cumulative impacts.

The above potential environmental and social issues have been reviewed, assessed, and addressed in the EIA and EMP Reports in line with national legal frameworks.


The only key missing components to the regulatory frameworks in Namibia are benchmarks, limits, standards, and guidelines with respect to gaseous, liquid, and solid emissions. However, in the absence of the national gaseous, liquid, and solid emission limits for Namibia, the proposed project shall target the Multilateral Investment Guarantee Agency (MIGA) gaseous effluent emission level and liquid effluent emission levels. Noise abatement measures must target to achieve MIGA guidelines.

6.2.2 Public Consultations

Public and stakeholder consultation and engagement process has been implemented by the Proponent. According to the Environmental Impact Assessment (EIA) Regulations No. 30 of 2012 and the Environmental Management Act, (EMA), 2007, (Act No. 7 of 2007), a person conducting a public consultation process must give notice to all potential interested and affected parties of the application which is subjected to public consultation.

The EIA Regulations clearly state that potential interested and affected parties must be provided with a reasonable opportunity (21 days) to comment on the application under section 21(6) of the EIA Regulations. In line with the provisions of the regulations, advertisements were published in the local newspapers. The overall objectives of publishing the adverts in the local newspapers was to inform and notify all the Interested and Affected Parties (I&AP) about the proposed 2D seismic survey operations in PEL 73. Copies of the adverts are included in the EIA Report and attached as Annex 3.

6.2.3 Summary of the Field-Based Specialist Studies

The EIA and EMP process included the following site-specific specialist studies: Field-based flora and fauna and specialist contributions to the various sections of the EIA and EMP Reports through desktop reviews of published materials on water, archaeological, dust, noise, and socioeconomic.
7. BIBLIOGRAPHY

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NamWater. 2018. Drilling of six production borehole at the Katji na Katji water supply scheme.


2. FURTHER READING ON FAUNA AND FLORA


Hebbard, S. n.d. A close-up view of the Namib and some of its fascinating reptiles. ST Promotions, Swakopmund, Namibia.


2. Fauna and Flora Specialist Report
VERTEBRATE FAUNA AND FLORA ASSOCIATED WITH THE PEL 73 SEISMIC SURVEY AREA (BLOCKS 1819 & 1820), KAVANGO EAST AREA [Baseline Study]

SPECIALIST CONTRIBUTION:

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Vertebrate fauna and flora associated with the PEL 73 Seismic Survey area (Blocks 1819 & 1820), Kavango East Region

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<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Methods</td>
<td>4</td>
</tr>
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1 Introduction

A comprehensive literature study (desktop) of the vertebrate fauna (i.e. amphibians, birds, mammals and reptiles) and flora (i.e. larger trees/shrubs [>1m in height] and grasses) expected to occur in the general Kavango Basin - Blocks 1819 and 1820 [PEL 73] was conducted during December 2018 (Cunningham 2018). This was followed up by fieldwork conducted between 16-20 November 2020 (current study) to determine the effect that the proposed ground seismic survey, using surface weight drop with the Explorer 860 truck as source unit, may have on the bio-physical environment (vertebrate fauna and flora) within the development area and immediate surroundings (especially along the seismic survey lines - NS1/2/3 & EW1/2/3) (Figure 1).

Figure 1. The location of various seismic transects within PEL 73 (Blocks 1819 and 1820) south, southeast and east of Rundu (red/orange lines). The lines running from north to south are referred to as NS1/2/3/4/5 and from east to west as EW1/2/3/4/5, respectively. Exploration areas of interest (AOI) are also indicated by the dotted purple lines (ReconAfrica).

This literature review was to determine the actual as well as potential vertebrate fauna and flora associated with the general area commonly referred to as the Tree Savanna and Woodlands (Northern Kalahari) (Giess 1971) or a combination of North-eastern Kalahari Woodland; Eastern Drainage; Northern Kalahari and Omatako Drainage, with the North-eastern Kalahari Woodland being the dominant vegetation type (Mendelsohn et al. 2002) (Figure 2). The vegetation structure is classified as broadleaved woodlands (Mendelsohn et al. 2002). The most important perennial drainage line in the area is the Okavango River (to the north), while the most important ephemeral drainage line is the Omuramba Omatako which meanders down the centre between Blocks 1819 and 1820 (See Figure 1). The northeast wetlands including the Okavango River frontage have known distinctive values which include biotic richness, threatened plants and insects. Ephemeral rivers especially the larger ones such as the Omuramba Omatako  are viewed as sites of special ecological importance.
due to their biotic richness and high value for human subsistence and tourism, throughout Namibia (Curtis and Barnard 1998).

Figure 2. The Seismic Surveys within the PEL 73 area, falls within the Tree Savanna and Woodlands (Northern Kalahari) vegetation type (Giess 1971) (black star).

The Woodland Biome of which the PEL 73 area forms part of is not well represented in the protected area network in Namibia of which only 8.4% of the biome is protected (Barnard 1998). The closest Government protected areas are the Mangetti National Park and the Kaudum National Park. The Mangetti National Park falls within Block 1819 while the Kaudum National Park is on the eastern boundary of Block 1820 (See Figure 1). The Mangetti National Park (420km²) was proclaimed in 2008 while the Kaudum National Park (3,842km²) was proclaimed in 1989 (See www.met.gov.na).

Blocks 1819 and 1820 fall within the Kavango communal area with communal conservancies in the general area including the N#a-Jaquina (south), Nyae Nyae (southeast), Maurus Nekaro (northwest), Joseph Mbambangandu and Kapinga Kamwalye (north), George Mukoya and Muduva Nyangana (north-east) (NACSO 2010, See: www.nacso.org.na). There are ten registered community forests throughout the general area (from west to east: Katope, Ncumara, Ncamagoro, Mbeyo, Likwaterera, Cuma, Ncaute x 2, Gwotjinga and Hans Kanyinga) (See: www.nacso.org.na). There are no freehold (commercial) conservancies in the area. The closest freehold (commercial) conservancy is the Ngarangombe Conservancy located to the southwest in the Grootfontein area (Mendelsohn et al. 2002, See: www.canam.iway.na).

The general area is regarded as medium in overall (all terrestrial species) diversity (Mendelsohn et al. 2002). Overall terrestrial endemism of all species in the area on the other hand is low (Mendelsohn et al. 2002). The overall diversity and abundance of large
herbivorous mammals (big game) is viewed as "average" with oryx, kudu and giraffe dominant especially in areas bordering the National Parks while the overall diversity and density of large carnivorous mammals (large predators) is determined as "average" with 1-5 species expected e.g. leopard, brown hyena, spotted hyena, cheetah and wild dog (Mendelsohn et al. 2002).

It is estimated that at least 67 species of reptile, 32 amphibian, 116 mammal and 210 bird species (breeding residents) are known to or expected to occur in the general Kavango East region.

According to Maggs (1998) there are approximately 4344 higher plant species with the most species being within the grasses (422), composites (Asteraceae) (385), legumes (Fabaceae) (377) and fygies (Mesembryanthemaceae) (177), recorded from Namibia. Total species richness depends on further collecting and taxonomic revisions.

High species richness is found in the Okavango, Otavi/Karsveld, Kaokoveld, southern Namib and Central Highland (Windhoek Mountains) areas. Endemic species approximately 687 species in total are mainly associated with the Kaokoveld (north-western) and the succulent Karoo (south-western) Namibia. The major threats to the floral diversity in Namibia are:

1). Conversion of the land to agriculture (with associated problems) and,
2). poorly considered development (Maggs 1998, Mendelsohn et al. 2002).

**Tree Savanna and Woodlands (Northern Kalahari)**
A large variety of deciduous trees are found in the Savannah and Woodlands [Northern Kalahari area] vegetation type. The grasses are usually hard and unpalatable in this area with *Antheophora pubescens, Brachiaria nigropedata and Schmidtia pappophoroides* viewed as the climax grasses in the open savannah areas (Giess 1971).

The general area has a "medium" plant diversity of between 300-399 species although the Okavango River to the north has a higher diversity (400-499 species). The endemism is viewed as "low" throughout with no species viewed as endemic (Mendelsohn et al. 2002). Simmons (1998a) puts the plant endemism in the general area at between 1-10 species depending on the locality. These estimates are limited to "higher" plants as information regarding "lower" plants is sparse.

The greatest variants affecting the diversity of plants are habitat and climate with the highest plant diversity generally associated with high rainfall areas. Pockets of high diversity are found throughout Namibia in "unique" habitat often transition zones e.g. mountains, inselbergs, etc. and riparian areas.

Furthermore, Mendelsohn et al. (2002) views the overall plant production as "very to extremely high" while the variation in plant production is mostly "very low to low" (0-10%) although dependant on the location.

The grazing potential is viewed as "low to average" in the general area while the browse potential is viewed as "good". Bush thickening (encroachment) is not viewed as problematic in the general area (Bester 1996, Cunningham 1998). The risk of farming is viewed as "low" with the tourism potential viewed as "average to high" (Mendelsohn et al. 2002).

It is estimated that at least 107 species of larger trees and shrubs (>1m in height) and up to 111 species of grasses are known to or expected to occur in the general area, none of which are viewed as endemic.
2 Methods

2.1 Literature Review

A comprehensive and intensive literature review (i.e. desktop study) regarding the vertebrate fauna (i.e. reptiles, amphibians, mammals and birds) and flora (i.e. trees/shrubs >1m in height and grasses) that could potentially occur in the general area was conducted using as many references as manageable. A list of the references consulted can be viewed in the Reference section (Page 66). This was conducted during the Scoping Study (See Cunningham 2018).

2.2 Field Survey

Vertebrate fauna

According to the original ToR, a rapid fieldwork assessment was conducted between 16 and 20 November 2020 to determine the actual faunal diversity and would include the following:

- Small mammal transects to determine small mammal diversity in the area
- Assess larger mammal presence in the area
- Reptile and amphibian transects to determine reptile and amphibian diversity in the area
- Bird transects to determine avian diversity in the area
- Tree/shrub transects to determine diversity in the area
- Grass transects to determine diversity in the area

Reptiles

Diurnal reptile transects were conducted along various transects throughout the proposed development area and were not conducted in rigid straight lines, but focused on the habitat viewed as most suitable for reptiles. Reptiles observed were either caught by hand or by using an active capture technique called ‘reptile noosing’ where an extendable fishing rod was fitted with a soft thread noose, positioned over the unsuspecting head of an individual and pulled tight. This technique does not result in the death or injury of the caught specimen. Species caught were identified in situ, photographed and released unharmed at the point of capture.

Amphibians

Amphibians were searched for in areas deemed suitable habitat e.g. drainage lines, pans, etc. with species encountered identified in situ.

Mammals

Small mammal trapping was conducted by active trapping using collapsible aluminium Sherman traps baited with peanut butter and oats. Traps were set at 3 sites throughout the area with thirty (30) traps used and were placed 20m apart for 3 nights (i.e. potential maximum of 90 captures) within the general area in habitats viewed as potentially suitable for small mammals in the area.

Assessing larger mammals from the area was conducted by traversing the area on foot and included actual sightings, tracks, scats and other signs e.g. burrows, scrapes, carcasses, etc.

Birds
Bird transects (variable lengths, directions and times) were conducted on foot and by vehicle following permissible tracks throughout the area (when in vehicle) during daylight hours using binoculars to identify and confirm species.

**Flora**

According to the original Terms of Reference (ToR), fieldwork to determine the actual floral diversity was to include the following:

- Trees and shrubs i.e. species composition
- Grasses i.e. species composition

**Trees, shrubs and grasses**

Vegetation composition was assessed at various survey sites located between 5 and 10km apart along vehicle tracks along the general seismic survey routes (See Figure 1). Seismic survey routes run from north to south and east to west (e.g. NS1/2/3 and EW1/2/3). The vegetation assessments were conducted at the following points along the various seismic routes:

**NS1**
- 18°10'59.5" & 19°45'2.5" [Ncuncuni area] 1
- 18°14'39.3" & 19°44'4.0" [Ncuncuni area] 2
- 18°17'59.9" & 19°46'4.3" [Ncuncuni area] 3
- 18°21'53.9" & 19°49'8.5" [Ncute area] 4
- 18°24'27.4" & 19°47'53.2" [Ncute area] 5
- 18°28'0.7" & 19°45'1.0" [Ncute area] 6
- 18°32'7.1" & 19°43'8.5" [Ncute area] 7
- 18°36'8.6" & 19°42'3.2" [Ncute area] 8

**NS2**
- 18°16'7.7" & 20°04'1.0" [Kawe area] 1
- 18°11'53.2" & 20°05'2.3" [Kawe area] 2

**NS3**
- 18°02'8.3" & 20°46'4.8" [Katere area] 1
- 18°05'4.2" & 20°46'2.2" [Katere-Kaudum area] 2
- 18°06'8.4" & 20°46'3.6" [Katere-Kaudum area] 3

**EW1**
- 18°08'5.5" & 19°46'7.8" [Ncuncuni area] 1
- 18°09'51.4" & 19°49'2.3" [Ncuncuni area] 2
- 18°10'59.5" & 19°51'25.2" [Cuma area] 3
- 18°12'1.9" & 19°53'54.3" [Cuma area] 4
- 18°06'3.4" & 19°45'27.4" [Ncuncuni area] 5
- 18°04'57.2" & 19°35'3.9" [Ncamagoro area] 6

**EW2**
- 18°10'5.3" & 20°09'46.8" [NE Kawe area] 1
- 18°11'52.6" & 20°14'59.8" [NE Kawe area] 2
- 18°12'03.5" & 20°17'06.6" [NE Kawe area] 3

**EW3**
- 18°21'5.7" & 19°54'48.7" [Ncute-Kawe area] 1
- 18°19'57.3" & 19°59'23.1" [Kawe area] 2

A rapid assessment of all the trees and shrubs was conducted at each survey site i.e. within a 200m radius of the site. Areas without vehicle access could not be assessed during this survey.

Fieldwork was limited to the accessible areas i.e. along vehicle tracks i.e. while other areas without vehicle tracks were not accessible during the fieldwork and thus not surveyed.
3 Results

3.1 Reptile Diversity

Reptile diversity known and/or expected to occur in the general PEL 73 area (literature study only), including species confirmed during the fieldwork as well as the authors confirmed records during other studies from the general area, is presented in Table 1.

Approximately 261 species of reptiles are known or expected to occur in Namibia thus supporting approximately 30% of the continents species diversity (Griffin 1998a). At least 22% or 55 species of Namibian lizards are classified as endemic. The occurrence of reptiles of conservation concern includes about 67% of Namibian reptiles (Griffin 1998a). Emergency grazing and large scale mineral extraction in critical habitats are some of the biggest problems facing reptiles in Namibia (Griffin 1998a).

The overall reptile diversity and endemism in the general area is estimated at between 41-60 species and 1-4 species, respectively (Mendelsohn et al. 2002). Simmons (1998) indicates that 1-6 endemic reptiles are expected from the general area while Griffin (1998a) presents figures of between 1-30 and 41-50 for indigenous lizards and snakes, respectively. The closest Government protected area – Kaudum National Park – has an estimated 66 species of reptiles although no data for Mangetti National Park is included (Griffin 1998a).

At least 67 species of reptiles are expected to occur in the general area with 2 species being endemic, Ichnotropis grandiceps and Lygodactylus bradfieldi (i.e. 3% endemic). Three species are viewed as rare (Lycophidion multimaculatum, Psammophis jallae, Causus rhombeatus); 6 species as vulnerable (Stigmochelys pardalis, Psammobates oculiferus, Kinixys spekii, Python natalensis, Varanus albogularis, Varanus niloticus); 7 species as protected game (Stigmochelys pardalis, Psammobates oculiferus, Kinixys spekii, Python natalensis, Varanus albogularis, Varanus niloticus, Crocodylus niloticus); 3 species as insufficiently known (Lycophidion multimaculatum, Psammophis jallae, Causus rhombeatus) and 7 species as peripheral. All the other species are classified as "secure". Seventeen species have some form of international conservation status – i.e. IUCN (2020) lists 16 species as least concern and 2 species as data deficient i.e. Pelusios (bechuanicus) upembae and Ichnotropis grandiceps (all other species have not yet been assessed by the IUCN Red List); SARDB (2004) lists 4 species as vulnerable and 3 species as peripheral and CITES lists 8 species as C2 i.e. Appendix 2 species. Some species have more than one conservation status.

The 67 species expected to occur in the general area consist of at least 3 tortoises (all vulnerable and protected game), 3 terrapins, 31 snakes (2 blind snakes, 1 thread snake, 1 python, 1 burrowing snake, 1 purple glossed, 1 quill snouted and 24 typical snakes) of which 3 species are classified as rare and 1 species as vulnerable, 5 worm lizards, 8 skinks, 4 old world lizards, 2 plated lizards, 2 monitor lizards, 1 agama, 1 chameleon and 6 geckos and 1 crocodile.

Snakes (31 species), skinks (8 species) and 6 geckos are the most important groups of reptiles expected from the general area.

Namibia with approximately 129 species of lizards (Lacertilia) has one of the continents richest lizard fauna (Griffin 1998a). Geckos expected and/or known to occur in the general area have the highest occurrence of endemics (78.6%) of all the reptiles in this area. Griffin (1998a) confirms the importance of the gecko fauna in Namibia.
Table 1. Reptile diversity expected (literature study) and confirmed (fieldwork) including author’s confirmed records from other studies conducted from the general area.

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### Baseline study: Vertebrate Fauna & Flora - Cunningham

**PEL 73 Seismic Survey (Kavango East Region) – November 2020**

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<thead>
<tr>
<th>Species: Scientific name</th>
<th>Species: Common name</th>
<th>Species confirmed</th>
<th>Namibian conservation and legal status</th>
<th>International status</th>
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<td>Nile Crocodile</td>
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<td>Peripheral; Protected Game</td>
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</tr>
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</table>

Namibian conservation and legal status according to the Namibian Conservation Ordinance of 1975 (Griffin 2003)

Endemic includes endemic species to South Africa (Branch 1998)

IUCN (2020) – International Union for the Conservation of Nature and Natural Resources [All species not listed by the IUCN (2020) have not yet been assessed for the IUCN Red List]. DD = Data Deficient; LC = Least Concern


CITES – Convention on International Trade in Endangered Species of Wild Fauna and Flora

C2 = CITES Appendix 2 species.

❑1 Visser (2010)

❑2 Cunningham and Adank (2005)
Authors personal records from general area
Author confirmed along the Okavango River

During the fieldwork only 2 species were confirmed along the various seismic survey routes assessed (Figure 3) and 13 species from the general area i.e. along the Okavango River (e.g. monitor lizards (Figure 4), crocodile) and/or using previous records and publications (e.g. Cunningham and Adank 2005, Visser 2010). This included 3 tortoises, 1 python, 5 typical snakes, 2 Old World lizards, 2 monitors, 1 chameleon and crocodile i.e. a total of at least 14 species are confirmed from the general area i.e. See Table 1. However, species such as the Nile/water monitor and crocodile are exclusively associated with the Okavango River system only i.e. would not occur in the inland areas. The presence of the tortoises, rock monitor and python, are also expected to be tenuous and patchy as they are traditionally collected as veld foods and expected to be extirpated throughout most of the area inhabited by humans. The lack of reptiles observed during the fieldwork would mainly be ascribed to the weather which was overcast with rain showers.

Figure 3. Cape rough-scaled lizard (*Ichnotropis capensis*) was observed at two locations in the general Kawe area along the EW3 seismic route.

Figure 4. Rock or white-throated monitor (*Varanus albigularis*) observed close to the Okavango River.
The most important species are viewed as those with some form of conservation status (Namibian and International) with the tortoises, pythons and monitor lizard probably the most important groups of reptiles in the general area. Tortoises and the monitor lizard are often killed for food or succumb as road kills while snakes are killed for various reasons often on sight. The 2 endemics (Ichnotropis grandiceps and Lygodactylus bradfieldii), 3 species classified as rare (Lycophidion multimaculatum, Psammophis jallae, Causus rhombeatus) and 6 species classified as vulnerable (Stigmochelys pardalis, Psammobates oculiferus, Kinixys spekii, Python natalensis, Varanus albigularis, Varanus niloticus) are viewed as the most important species in the general area. The 2 species classified as data deficient by the IUCN (2020) – Pelusios bechuanicus and Ichnotropis grandiceps – are also viewed as important although P. upembae would be associated with the Okavango River system only. Due to the fact that reptiles are an understudied group of animals, especially in Namibia, it is expected that more species may be located in the general area than presented in Table 1.

The general area has been heavily impacted in places, especially along the Omuramba Omatako and areas close to towns and settlements such as Rundu and Ncaute, etc., due to subsistence farming and logging activities and none of the unique reptiles are expected to be exclusively associated with the seismic survey routes. The proposed mitigations – See Section 4 – are expected to minimise the overall effect on reptiles potentially occurring in the area.

Impact of ground seismic survey:
A typical weight drop would have a peak force output of 860,000lbs (~430,000kg) at baseplate with an impulse frequency of 300Hz and a maximum cycle time of 10 seconds (Explorer 860 technical overview). Monk et al. (2004) indicates that although some compaction of the soil surface occurs, there is little or no long term damage to the surface. Although the precise impact of using this technology on reptile fauna is unknown, disturbances would be of short duration and it is not expected that the ground seismic survey, using weight drop technology, will have any lasting negative impacts on reptiles in the general area.

Habitat destruction, due to the creation and widening of new tracks, is more important although the actual footprint is small. However, no new tracks are envisaged and all seismic activity will be conducted along existing roads and tracks throughout the area. This would thus not lead to additional habitat disturbances and increased access into areas currently not as easily accessible which could lead to increased mortalities (e.g. vehicle mortalities and killing of perceived dangerous species such as snakes) and illegal collection of reptiles as food (e.g. tortoises and monitor lizards), etc.

3.2 Amphibian Diversity

Amphibian diversity known and/or expected to occur in the general PEL 73 area (literature study only), including species confirmed during the fieldwork as well as the authors confirmed records during other studies from the general area, is presented in Table 2.

Table 2. Amphibian diversity expected (literature study) and confirmed (fieldwork) including author’s confirmed records from other studies conducted from the general area.

<table>
<thead>
<tr>
<th>Species: Scientific name</th>
<th>Species: Common name</th>
<th>Namibian conservation and legal status</th>
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<td>Rain Frogs</td>
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<td>Toads</td>
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<td>Tomopterna tandy</td>
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</table>

φ = Species potentially occurring in the general area along the Omurumba Omatako (other species associated with the Okavango River)

Namibian conservation and legal status according to the Namibian Conservation Ordinance of 1975 (Griffin 2003)

NT* = Near Threatened (Minter et al. 2004)

IUCN (2020) The International Union for the Conservation of Nature and Natural Resources; LC = Least Concern

Amphibians are declining throughout the world due to various factors of which much has been ascribed to habitat destruction. Basic species lists for various habitats are not always available with Namibia being no exception in this regard while the basic ecology of most species is also unknown. Approximately 4,000 species of amphibians are known worldwide with just over 200 species known from southern Africa and at least 57 species expected to occur in Namibia. Griffin (1998b) puts this figure at 50 recorded species and a final species richness of approximately 65 species, 6 of which are endemic to Namibia. This low number of amphibians from Namibia is not only as a result of the generally marginal desert habitat, but also due to Namibia being under studied and under collected. Most amphibians require water to breed and are therefore associated with the permanent water bodies, mainly in northeast Namibia.

According to Mendelsohn et al. (2002), the overall frog diversity in the general area is estimated at between 12-27 species with the latter total associated with the Okavango River. Griffin (1998b) puts the species richness in the general area at 14-29 species. The closest Government protected area – Kaudum National Park – has an estimated 19 species of amphibians although no data for Mangetti National Park is included (Griffin 1998b). The most important species from the area is viewed as the giant bullfrog (*Pyxicephalus adspersus*) with populations are decreasing according to the IUCN (2020) as it is consumed as food throughout its range (Griffin pers. com.). No endemics occur in the area (Simmons 1998a).

According to the literature, at least 32 species of amphibians can occur in suitable habitat in the general area although only 17 species potentially occur in the general area. The area is under represented, with 1 tree frog, 1 rain frog, 4 toads, 1 pygmy toad, 2 shovel-nosed toads, 3 reed frogs, 1 kassina, 2 rubber frogs, 3 puddle frogs, 1 ornate frog, 5 grass frogs, 3 platannas, 1 caco, 1 bullfrog and 3 sand frogs known and/or expected (i.e. potentially could be found in the area) to occur in the area. Of these, none are endemic from the general area.

During the fieldwork no amphibians were observed throughout the general area although there was some open surface water observed in parts of the Omuramba Omatako after localised rain showers (Figure 5). The lack of amphibians observed during the fieldwork would mainly be ascribed to limited time on site; first rains not yet having stimulated much amphibian activity and most of the Omuramba areas having been ploughed and cultivated (Figure 6).

Figure 5. Water starting to collect in the general Omuramba Omatako area after the first rain showers in the area.
The most important species from the area is the giant bullfrog (*Pyxicephalus adspersus*) with populations are decreasing according to the IUCN (2020) as it is consumed as food throughout its range (Griffin pers. com.). Most amphibians are expected to be associated with the Okavango River system in the area rather than the sandy interior, although the ephemeral Omuramba Omatako and pans throughout the general area would also be suitable habitat.

The general area has been heavily impacted in places, especially along the Omuramba Omatako and areas close to towns and settlements such as Rundu and Ncute, etc., due to subsistence farming and logging activities and none of the unique amphibians are expected to be exclusively associated with the seismic survey routes. The proposed mitigations – See Section 4 – are expected to minimise the overall effect on amphibians potentially occurring in the area.

**Impact of ground seismic survey:**
A typical weight drop would have a peak force output of 860,000lbs (~430,000kg) at baseplate with an impulse frequency of 300Hz and a maximum cycle time of 10 seconds (Explorer 860 technical overview). Monk et al. (2004) indicates that although some compaction of the soil surface occurs, there is little or no long term damage to the surface. Although the precise impact of using this technology on amphibian fauna is unknown, disturbances would be of short duration and it is not expected that the ground seismic survey, using weight drop technology, will have any lasting negative impacts on amphibians in the general area.

Habitat destruction, due to the creation and widening of new tracks, especially through the Omuramba Omatako (and other ephemeral drainage lines), is more important although the actual footprint is small. However, no new tracks are envisaged and all seismic activity will be conducted along existing roads and tracks throughout the area. This would thus not lead to additional habitat disturbances and increased access into areas currently not as easily accessible which could lead to increased mortalities (e.g. vehicle mortalities) and illegal collection of amphibians as food (e.g. giant bullfrog), etc.

### 3.3 Mammal Diversity
Mammal diversity known and/or expected to occur in the general PEL 73 area (literature study only), including species confirmed during the fieldwork as well as the authors confirmed records during other studies from the general area, is presented in Table 3.

Namibia is well endowed with mammal diversity with at least 250 species occurring in the country. These include the well known big and hairy as well as a legion of smaller and lesser-known species. Currently 14 mammal species are considered endemic to Namibia of which 11 species are rodents and small carnivores of which very little is known. Most endemic mammals are associated with the Namib and escarpment with 60% of these rock-dwelling (Griffin 1998c). According to Griffin (1998c) the endemic mammal fauna is best characterized by the endemic rodent family *Petromuridae* (Dassie rat) and the rodent genera *Gerbillurus* and *Petromyscus*.

High mammal richness is greatly enhanced by the major river systems running through the Kavango area (Griffin 1998c). These rivers also support marginal populations of many tropical African species. Deforestation affects the tree dependent and wetland dependent mammals in the area while 10% of Namibia’s mammal species depend on, or are restricted to, wetland habitats. All the inland species, including species associated with the rivers, are under some threat and thus ultimately at risk with only a small section of the Okavango River formally protected (Griffin 1998c).

The overall mammal diversity in the general area is estimated at between 76-90 species with no species being endemic to the area (Mendelsohn et al. 2002). Griffin (1998c) puts the species richness distribution of endemics at 9-11 species in the general area while Simmons (1998a) indicates that no endemics occur in the area. The closest Government protected area – Kaudum National Park – has an estimated 92 species of mammals although no data for Mangetti National Park is included (Griffin 1998c).

According to the literature at least 116 species of mammals are expected to occur in the general area although not all the species (i.e. 11 species) indicated in Table 3 are found away from the Okavango River and associated floodplains – e.g. otters, hippo, etc.
Table 3. Mammal diversity expected (literature study) and confirmed (fieldwork) including authors confirmed records from other studies conducted from the general area.

<table>
<thead>
<tr>
<th>Species: Scientific name</th>
<th>Species: Common name</th>
<th>Species confirmed</th>
<th>Namibian conservation and legal status</th>
<th>International status:</th>
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<tbody>
<tr>
<td><strong>Shrews</strong></td>
<td></td>
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<tr>
<td>Crosidura mariquensis</td>
<td>Swamp Musk Shrew cp</td>
<td>Insufficiently known; Vulnerable?</td>
<td>DD</td>
<td></td>
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<td>Crosidura fuscomurina</td>
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<td>Secure</td>
<td>DD</td>
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<tr>
<td>Crosidura (occidentalis) olivieri</td>
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<td>Peripheral</td>
<td>DD</td>
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<td>DD</td>
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<tr>
<td><strong>Aardvark</strong></td>
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<tr>
<td>Orycteropus afer</td>
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<td>African Savanna Elephant</td>
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<td>V C2</td>
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<td>Monkeys, Baboons and Bushbaby</td>
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<td>Hares and Rabbits</td>
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<tr>
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<td>Scrub Hare</td>
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<td>Cryptomys (Fukomys) damarensis</td>
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<td>Secure</td>
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<td>Squirrels</td>
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<td></td>
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<tr>
<td>Paraxerus cepapi</td>
<td>Tree Squirrel</td>
<td>♀♂</td>
<td>Secure</td>
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</table>
### Baseline study: Vertebrate Fauna & Flora - Cunningham

#### PEL 73 Seismic Survey (Kavango East Region) – November 2020

<table>
<thead>
<tr>
<th>Species: Scientific name</th>
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<th>SARDB</th>
<th>IUCN</th>
<th>CITES</th>
</tr>
</thead>
</table>

#### Porcupine, Canerat, Springhare, Squirrel
- *Hystrix africaeaustralis*: Cape Porcupine  
- *Thryonomys swinderianus*: Greater Canerat  
- *Pedetes capensis*: Springhare

#### Dormice, Rats and Mice
- *Graphiurus murinus*: Woodland Dormouse  
- *Lemniscomys rosalia*: Single-striped Grass Mouse  
- *Zelotomys wosnami*: Dessert Mouse  
- *Mus setzeri*: Pygmy Mouse  
- *Mus indutus*: Desert Pygmy Mouse  
- *Mastomys natalensis*: Natal Multimammate Mouse  
- *Mastomys coucha*: Southern Multimammate Mouse  
- *Mastomys shortridgei*: Shortridge's Mouse  
- *Thallomys paedulcus*: Acacia Rat  
- *Thallomys nigricauda*: Black-tailed Tree Rat  
- *Aethomys chrysophilus*: Red Veld Rat  
- *Aethomys namaquensis*: Namaqua Rock Mouse  
- *Ototmys angoniensis*: Angoni Vlei Rat  
- *Gerbillurus paeba*: Hairy-footed Gerbil  
- *Tatera (Gerbilliscus) leucogaster*: Bushveld Gerbil  
- *Tatera (Gerbilliscus) brantsii*: Highveld Gerbil  
- *Saccostomus campestris*: Pouched Mouse  
- *Dendromus melanotis*: Grey Climbing Mouse  
- *Dendromus mesomelas*: Brants' Climbing Mouse  
- *Steatomys pratensis*: Fat Mouse  
- *Steatomys parvus*: Tiny Fat Mouse

#### Carnivores
- *Proteles cristatus*: Aardwolf  
- *Crocuta crocuta*: Spotted Hyena  
- *Acinonyx jubatus*: Cheetah  
- *Panthera pardus*: Leopard  
- *Panthera leo*: Lion

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Insufficiently Known; Vulnerable?; Peripheral; Protected Game

Secure; Peripheral; Protected Game

Vulnerable; Protected Game

Secure; Peripheral; Protected Game

Indeterminate; Vulnerable?; Peripheral; Protected Game

V

V

C1

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C1

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C2
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<td><em>Raphicerus campestris</em></td>
<td>Steenbok</td>
<td>Secure; Protected Game</td>
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</tbody>
</table>

Δ = Species associated with the Okavango River

Namibian conservation and legal status according to the Namibian Conservation Ordinance of 1975 (Griffin 2003)

SARDB (2004): South African Red Data Book; E = Endangered; V = Vulnerable; NT = Near Threatened; DD = Data Deficient

IUCN (2020): E = Endangered; V = Vulnerable; NT = Near Threatened. All other species listed as Least Concern (LC) [All species not listed have not yet been assessed for the IUCN Red List].


# Monadjem *et al.* (2010): V = Vulnerable; NT = Near Threatened; DD = Data Deficient

* Authors personal records from general area

# Authors confirmed along the Okavango River

Of the species expected to occur in the greater area, 6 species are viewed as rare (Nycteris hispida, Kerivoula argentata, Kerivoula lanosa, Mastomys shortridgei, Civittictis civetta, Paracybactis selousi), 3 endangered (Lycaon pictus, Lutra maculicollis, Equus (burchelli) quagga), 15 vulnerable, 3 specially protected game, 20 protected game, 7 indeterminate, 10 insufficiently known, 4 huntable game, 3 problem animals, 25 peripheral and 12 not listed under Namibian legislation (Griffin and Coetzee 2005). The IUCN (2020) classifies 1 species as endangered (Lycaon pictus), 7 species as vulnerable (Loxodonta africana, Smutsia (Manis) temminckii, Acinonyx jubatus, Panthera pardus, Panthera leo, Hippopotamus amphibious, Giraffa camelopardalis) and 3 species as near threatened (Hipposideros vittatus, Aonyx capensis, Hydrichtis (Lutra) maculicollis). The SARDB (2004) classifies 2 species as endangered, 5 species as vulnerable, 12 species as near threatened and 7 species as data deficient while CITES lists 2 species as Appendix I and 12 species as Appendix II. Some species have more than one classification. The House Mouse (Mus musculus) is viewed as an invasive alien species to the area. Mus musculus are generally known as casual pests and not viewed as problematic although they are known carriers of "plague" and can cause economic losses (Picker and Griffiths 2011).

Habitat alteration and overutilization are the two primary processes threatening most mammals (Griffin 1998c) with species probably underrepresented in Table 3 for the general area being the bats and rodents, as these groups have not been well documented from the arid central-western part of Namibia.

At least 31.9% 21.6% and 18.1% of the mammalian fauna that occur or are expected to occur in the general area are represented bats (37 species), carnivores (25 species) and rats and mice (21 species). Habitat alteration and overutilization are the two primary processes threatening most mammals in Namibia (Griffin 1998c). Mammal species probably underrepresented in Table 3 for the general area are bats and rodents, as these groups have not been well documented from the general area.

During the fieldwork only 2 species were confirmed along the various seismic survey routes assessed (Figure 7) and 7 species from the general area i.e. along the Okavango River (e.g. otter and hippo) and/or using the author's previous records. This included Damaraland mole-rat, tree squirrel, serval, African clawless otter, slender and banded mongoose, hippo, common duiker and steenbok i.e. a total of at least 9 species are confirmed from the general area i. See Table 3. However, species such as the African clawless otter and hippo are exclusively associated with the Okavango River system only i.e. would not occur in the inland areas.

The presence of larger mammals, are also expected to be tenuous and patchy as they are traditionally hunted as veld foods and expected to be extirpated throughout most of the area inhabited by humans. No small mammals were trapped over three nights with a maximum of 90 potential captures. The lack of mammals observed during the fieldwork would mainly be ascribed to limited time on site; overcast and rainy weather conditions and overall area habituated with low to dense human presence (Figure 8).
Figure 7. Damaraland mole-rat (*Cryptomys (Fukomys) damarensis*) mounds observed on the road verge.

Figure 8. Human settlements and overall presence affects the presence and abundance of mammals throughout the general area.

The most important species from the general area are probably those classified as rare (*Nycteris hispida, Kerivoula argentata, Kerivoula lanosa, Mastomys shortridgei, Civittictis civetta, Paracycnoctis selousi*) and endangered (*Lycaon pictus, Lutra maculicolis, Equus (burchelli) quagga*) under Namibian legislation and those classified by the IUCN (2020) as endangered (*Lycaon pictus*), vulnerable (*Loxodonta africana, Smutsia (Manis) temminckii, Acinonyx jubatus, Panthera pardus, Panthera leo, Hippopotamus amphibious, Giraffa cemelopardalis*) and near threatened (*Hipposideros vittatus, Aonyx capensis, Hydricitics (Lutra) maculicollis*). However, some of the above species e.g. otter, hippo, etc. are only associated with the Okavango River. The most important species expected to occur in the general area would be the African wild dog (*Lycaon pictus*) and pangolin (*Smutsia (Manis) temminckii*).
The general area has been heavily impacted in places, especially along the Omuramba Omatako and areas close to towns and settlements such as Rundu and Ncaute, etc., due to subsistence farming and logging activities and none of the unique mammals are expected to be exclusively associated with the seismic survey routes. The proposed mitigations See Section 4 II are expected to minimise the overall effect on mammals potentially occurring in the area.

**Impact of ground seismic survey:**

A typical weight drop would have a peak force output of 860,000 lbs (~430,000 kg) at baseplate with an impulse frequency of 300 Hz and a maximum cycle time of 10 seconds (Explorer 860 technical overview). Monk et al. (2004) indicates that although some compaction of the soil surface occurs, there is little or no long term damage to the surface. Although the precise impact of using this technology on mammal fauna is unknown, disturbances would be of short duration and it is not expected that the ground seismic survey, using weight drop technology, will have any lasting negative impacts on mammals in the general area.

Elephant are known to use infrasound communication with frequencies from 14-35 Hz for long distance communication with the best period for such communication just after sunset when night-time cooling enhances low-frequency sounds and thus maximises communication ranges (Garstang et al. 1995). Furthermore, elephant also use seismic communication – i.e. ground borne stimuli which works better in sandy soils – to avoid or threaten predators, assess and navigate within the environment, and communicate (O’Connell-Rodwell et al. 2007). Human noise in the 20-25 Hz frequency range can interfere with the transmission of seismic waves which could increasingly impede elephant seismic communication (Mortimer et al. 2018). However, elephant are not sedentary in the proposed development area and mainly located to the east, in the Kaudum National Park with occasional movements to the west and south, between Kaudum and Mangetti National Parks and north-east between the Kaudum National Park and the Mahangu Core Area. The seismic surveys will be executed to the north and west of most elephant activities as well as be conducted during daylight hours – i.e. expected to have limited impact on elephant communication. A typical surface weight drop using the Explorer 860 truck as source unit would have an impulse frequency of 300 Hz and a maximum cycle time of 10 seconds per sampling site – i.e. above the range elephants use for communication and be of short duration (Monk et al. 2004).

Habitat destruction, due to the creation and widening of new tracks, is more important although the actual footprint is small. However, no new tracks are envisaged and all seismic activity will be conducted along existing roads and tracks throughout the area. This would thus not lead to additional habitat disturbances and increased access into areas currently not as easily accessible which could lead to increased mortalities (e.g. vehicle mortalities and killing of perceived dangerous species such as wild dog, lion, etc.) and illegal collection of mammals as food (e.g. various ungulates) or trade (e.g. pangolin).

### 3.4 Avian Diversity

Bird diversity known and/or expected to occur in the general PEL 73 area (literature study only), including species confirmed during the fieldwork as well as the authors confirmed records during other studies from the general area, and is presented in Table 4.

Although Namibia’s avifauna is comparatively sparse compared to the high rainfall equatorial areas elsewhere in Africa, approximately 658 species have already been recorded with a diverse and unique group of arid endemics (Brown et al. 1998, Maclean 1985). Fourteen species of birds are endemic or near endemic to Namibia with the majority of Namibian endemics occurring in the savannas (30%) of which ten species occur in a north-south belt of
Table 4. Bird diversity expected (literature study) and confirmed (fieldwork) including author's confirmed records from other studies conducted from the general area. This table excludes marine and other aquatic birds (e.g. Petrel, Albatross, Skua, and various ducks, etc.) and species breeding extralimital (e.g. stints, sandpipers, etc.) and rather focuses on birds that are breeding residents or can be found in the area during any time of the year. This would imply that many more birds (e.g. Palaearctic migrants) could occur in the area depending on favourable environmental conditions.

<table>
<thead>
<tr>
<th>Species: Scientific name</th>
<th>Species: Common name</th>
<th>Species confirmed</th>
<th>Namibian conservation and legal status</th>
<th>International status</th>
<th>Southern Africa</th>
<th>IUCN (2020)</th>
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Namibian (Simmons *et al.* 2015): CE î Critically Endangered; E î Endangered; V î Vulnerable; NT î Near Threatened
Southern African (Hockey *et al.* 2006): End î Endemic; N-end î Near Endemic
IUCN (2020): CE î Critically Endangered; E î Endemic; V î Vulnerable; NT î Near Threatened; All other birds either listed as least concern or not yet been assessed for the IUCN Red List

â*î Authors personal records from general area

ã#î Author confirmed along the Okavango River

At least 210 species of terrestrial ["breeding residents"] birds occur and/or could occur in the general area, focus on the general area and excludes birds associated with the Okavango River at any time. All the aquatic, extralimital breeders and migrant species have been excluded here. Only one rosy-faced lovebird of the 14 Namibian endemics is expected to occur in the general area. Six species are classified as endangered (hooded vulture, white-backed vulture, tawny eagle, martial eagle, bateleur, southern ground-hornbill), 3 species as vulnerable (secretarybird, white-headed vulture, lappet-faced vulture) and 3 species as near threatened (marabou stork, peregrine falcon, kori bustard) from Namibia (Simmons et al. 2015). The IUCN (2020) classifies 3 species as critically endangered (hooded vulture, white-headed vulture, white-backed vulture), 1 species as endangered (lappet-faced vulture), 4 species as vulnerable (secretarybird, tawny eagle, martial eagle, southern ground-hornbill) and 2 species as near threatened (bateleur, kori bustard).

Twenty seven species (12.9% of all the birds expected) have a southern African conservation rating with 2 species classified as endemic (7.4% of southern African endemics or 1% of all the birds expected) and 25 species classified as near endemic (92.6% of southern African endemics or 11.9% of all the birds expected) (Hockey et al. 2006).

Many species expected to occur in the general area are migratory e.g. bustards and korhaan and not found permanently in the area. Other species may frequent the area only if water collects in the Omuramba Omatako or whilst moving between wetlands in Etosha and Bushmanland e.g. cranes, ducks, flamingo, etc. As very little ringing/recording occurs in this part of Namibia, little is known about the distribution and ecology of many species from the general area with many more species expected to occur.

During the fieldwork only 44 species were confirmed along the various seismic survey routes assessed of which 7 species are not included in Table 4 as these are migratory or out of range species (i.e. barn swallow, red-billed oxpecker, yellow-billed kite, trac-trac chat, steppe buzzard, red-footed falcon) and another 40 species from the general area i.e. along the Okavango River and/or using the author’s previous records (Table 4).

However, many other aquatic species would be associated with the Okavango River, but not included here i.e. would not normally occur in the inland areas. The Omuramba Omatako may attract aquatic species in inland areas when water collects after rain showers. However, large areas of this Omuramba have now been ploughed for fields and altered by humans for subsistence farming degrading this once important habitat (Figures 9 and 10).
Figure 9. Large parts of the Omuramba Omatako have been altered by humans for farming purposes and have consequently become degraded as an aquatic avifauna habitat.

Figure 10. Fields are fenced and ploughed within the Omaramba Omatako.

The most important species are viewed as those classified as endangered (hooded vulture, white-backed vulture, tawny eagle, martial eagle, bateleur, southern ground-hornbill), vulnerable (secretarybird, white-headed vulture, lappet-faced vulture and) and near threatened (marabou stork, peregrine falcon, kori bustard) from Namibia (Simmons et al. 2015) as well as those classified by the IUCN (2020) as critically endangered (hooded vulture, white-headed vulture, white-backed vulture), endangered (lappet-faced vulture), vulnerable (secretarybird, tawny eagle, martial eagle, southern ground-hornbill) and near threatened (bateleur, kori bustard).

An important species confirmed from the general area is the red-billed oxpecker. Although their numbers have increased in communal areas in north-eastern Namibia (Robertson and Jarvis 2000), elsewhere they have been negatively affected due to arsenic-based cattle dips (Figure 11).
Figure 11. Red-billed oxpecker foraging on donkey in the Ncaute area.

The general area has been heavily impacted in places, especially along the Omuramba Omatako and areas close to towns and settlements such as Rundu and Ncaute, etc., due to subsistence farming and logging activities and none of the unique birds are expected to be exclusively associated with the seismic survey routes. The proposed mitigations (see Section 4) are expected to minimise the overall effect on mammals potentially occurring in the area.

Impact of ground seismic survey:
A typical weight drop would have a peak force output of 860,000lbs (~430,000kg) at baseplate with an impulse frequency of 300Hz and a maximum cycle time of 10 seconds (Explorer 860 technical overview). Monk et al. (2004) indicates that although some compaction of the soil surface occurs, there is little or no long term damage to the surface. Although the precise impact of using this technology on bird fauna is unknown, disturbances would be of short duration and it is not expected that the ground seismic survey, using weight drop technology, will have any lasting negative impacts on birds in the general area.

Habitat destruction, due to the creation and widening of new tracks, especially through the Omuramba Omatako (and other ephemeral drainage lines), is more important although the actual footprint is small. However, no new tracks are envisaged and all seismic activity will be conducted along existing roads and tracks throughout the area. This would thus not lead to additional habitat disturbances and increased access into areas currently not as easily accessible which could lead to increased mortalities (e.g. vehicle mortalities) and illegal hunting of birds as food (e.g. various game birds) or trade (e.g. Meyer’s parrot).

3.5 Tree and Shrub Diversity

The tree and shrub diversity known and/or expected to occur in the general PEL 73 area (literature study only), including species confirmed during the fieldwork as well as the authors confirmed records during other studies from the general area, is presented in Tables 5 and 6. Table 5 indicates tree and shrub diversity along the various seismic routes while Table 6 indicates tree and shrub diversity at each of the 24 vegetation survey points conducted.
Baseline study: Vertebrate Fauna & Flora - Cunningham

Table 5. Tree and shrub diversity expected (literature study, using Mannheimer and Curtis 2018) and confirmed (fieldwork) along each of the seismic survey routes. The focus is on the inland area along the seismic routes and excludes species associated with the Okavango River. Species indicated are known from the quarter-degree square distribution principle used and don’t necessarily occur throughout the entire area. NS1/2/3 and EW1/2/3 = Seismic survey routes from north to south and east to west (See Figure 1).

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<tr>
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<th>Namibian conservation and legal status</th>
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PEL 73 Seismic Survey (Kavango East Region) – November 2020
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<td>LC</td>
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<td>LC</td>
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<tr>
<td>Searsia marlothii</td>
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<td>Searsia tenuinervis</td>
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<td>Schinziophytion rautanenii</td>
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### Species: Scientific name

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<th>International status (IUCN 2020)</th>
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<tr>
<td><strong>Tarchonanthes camphoratus</strong></td>
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<td><strong>Terminalia brachystemma</strong></td>
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<td><strong>Terminalia prunioides</strong></td>
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<td><strong>Terminalia sericea</strong></td>
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<tr>
<td><strong>Tinnea eriocalyx</strong></td>
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<tr>
<td><strong>Vangueria cyanescens</strong></td>
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<td><strong>Ximenia caffra var. caffra</strong></td>
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<tr>
<td><strong>Ziziphus mucronata</strong></td>
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#### Important areas:
- KNP = Kaudum NP access route/narrow sandy track/relatively pristine area; O = Omuramba; OO = Omaramba Omatako; Pan = Small pans with *Combretum imberbe*

#### Invasive alien species:
- Euc = *Eucalyptus* spp.; O = *Opuntia* spp.; S = *Sisal* spp.

#### Wildlife tracks:

---

**F#**  |  Forest Act No. 12 of 2001
**NC**  |  Nature Conservation Ordinance No. 4 of 1975
**C2**  |  CITES Appendix 2 (Mannheimer and Curtis 2018)
**LR-nt**  |  lower risk, near threatened (Loots 2005)

Source for literature review: Mannheimer and Curtis (2018)
Table 6. Tree and shrub diversity expected and confirmed during the fieldwork at each of the 24 vegetation survey points conducted. NS and EW = Seismic survey routes from north to south and east to west (See Figure 1 and Methods Section for the GPS co-ordinates at each site).

<table>
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<th>Namibian conservation and legal status</th>
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<tr>
<td>Acacia erioloba</td>
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<td>Acacia erubescens</td>
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<tr>
<td>Acacia fleckii</td>
<td>√</td>
<td></td>
</tr>
<tr>
<td>Acacia hebeclada</td>
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<td></td>
</tr>
<tr>
<td>Acacia luederitzii</td>
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<td></td>
</tr>
<tr>
<td>Acacia mellifera</td>
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<td></td>
</tr>
<tr>
<td>Acacia tortilis</td>
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<td></td>
</tr>
<tr>
<td>Adansonia digitata</td>
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<td>Protected (F#)</td>
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<tr>
<td>Albizia anthelmintica</td>
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<td>Protected (F#)</td>
</tr>
<tr>
<td>Albizia antunesiana</td>
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<tr>
<td>Albizia harveyi</td>
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</tr>
<tr>
<td>Aloe litoralis</td>
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<td>Annona stenophylla</td>
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<td>Baiskea plurijuga</td>
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<td>Baissea wulfhorstii</td>
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<td>Baphia massaiensis</td>
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<td>Bauhinia petersiana</td>
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<td>Bauhinia urbaniana</td>
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<tr>
<td>Boscia albitrunca</td>
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</tr>
<tr>
<td>Burkia africana</td>
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<td></td>
</tr>
<tr>
<td>Catophractes alexandri</td>
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<td></td>
</tr>
<tr>
<td>Combretum apiculatum</td>
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<td>Combretum celastroides</td>
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<tr>
<td>Combretum collinum</td>
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<tr>
<td>Combretum engleri</td>
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<td>Combretum hereroense</td>
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PEL 73 Seismic Survey (Kavango East Region) – November 2020
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<td>Combretum psidioides</td>
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<td>Combretum zeyheri</td>
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<td>Commiphora africana</td>
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<tr>
<td>Commiphora angolensis</td>
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<td>Grewia bicolor</td>
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<tr>
<td>Grewia bicolor</td>
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<tr>
<td>Grewia falcistipula</td>
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<td>Species: Scientific name</td>
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<td>Namibian conservation and legal status</td>
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<td>Grewia flava</td>
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<td>Grewia olukondae</td>
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<td>Grewia retinervis</td>
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<td>Maerua schinzii</td>
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<td>Ochna pulchra</td>
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<td>Ozoroa longipes</td>
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<tr>
<td>Pavetta zeyheri</td>
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<td>Peptophorum africanum</td>
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<td>Psydrax livida</td>
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<td>Rhigozum brevispinosum</td>
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<td>Searsia ciliata</td>
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Baseline study: Vertebrate Fauna & Flora - Cunningham
## Species: Scientific name ||| Species confirmed ||| Namibian conservation and legal status
--- | --- | ---
Searsia marlothii ||| ☑ ☑ | Protected (F#)
Searsia tenuinervis ||| ☑ | Protected (F#)
Schinziopyton rautanenii ||| ☑ ☑ | Protected (F#)
Sclerocarya birrea ||| ☑ | Protected (F#)
Securidaca ||| | Protected (F#)
Longependunculata ||| | Protected (F#)
Steganotaenia araliacea ||| | Protected (F#)
Strychnos cocculoides ||| ☑ ☑ | Protected (F#)
Strychnos pungens ||| ☑ | Protected (F#)
Strychnos spinosa ||| ☑ | Protected (F#)
Swartzia madagascariensis ||| | Protected (F#)
Tarchonanthes camphoratus ||| | Protected (F#)
Terminalia brachystemma ||| | Protected (F#)
Terminalia prunioides ||| | Protected (F#)
Terminalia sericea ||| ☑ ☑ ☑ | Protected (F#)
Tinnea eriocalyx ||| | Protected (F#)
Vangueria cyanescens ||| | Protected (F#)
Vangueria infausta ||| | Protected (F#)
Ximenia americana ||| ☑ | Protected (F#)
Ximenia caffra var. caffra ||| | Protected (F#)
Ziziphus mucronata ||| | Protected (F#)

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### Important areas:
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<td>lower risk, near threatened (Loots 2005)</td>
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### Wildlife tracks:
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</tbody>
</table>

**Total number of species:** 16
**Important areas:**
- F# – Forest Act No. 12 of 2001
- NC – Nature Conservation Ordinance No. 4 of 1975
- C2 – CITES Appendix 2 (Mannheimer and Curtis 2018)
- LR-n – lower risk, near threatened (Loots 2005)
- Δ – Dominant species
Important areas: KNP = Kaudum NP access route/narrow sandy track/relatively pristine area; O = Omuramba; OO = Omaramba Omatako; Pan = Small pans with Combretum imberbe
Invasive alien species: Euc = Eucalyptus spp.; O = Opuntia spp.; S = Sisal spp.

Source for literature review: Mannheimer and Curtis (2018)
At least 107 species of larger trees/shrubs are expected to occur in the general area of which none are viewed as endemics. Eighteen species (16.8%) are protected by the Forest Act No. 12 of 2001 while 1 species is protected by the Nature Conservation Ordinance No. 4 of 1975 (0.9%) (Mannheimer and Curtis 2018). Three species are classified as Lower Risk (Near Threatened) (2.8%) (Loots 2005). Species with the most diversity expected from the general area are *Combretum* (10 species) and *Grewia* (10 species) followed by *Acacia* (8 species).

During the fieldwork a total of 43 larger trees and shrubs was confirmed from the various seismic routes with the NS1 (32 spp.) and EW2 (11 spp.) routes having the highest and lowest number of species, respectively (See Table 5). Of these 43 species, 12 species are protected by the Forest Act No12. of 2001 i.e. 27.9%. The actual vegetation survey points varied between 4 and 16 species, respectively (See Table 6) (Figures 12-17).

**Figure 12.** *Baikiaea plurijuga* (Zambezi teak ‒ Near Threatened, IUCN 2020) ‒ protected ‒ has been targeted extensively for illegal logging purposes.

**Figure 13.** *Burkea africana* (burkea) ‒ protected ‒ are some of the taller trees in the area and are targeted for timber and firewood production.
Figure 14. *Guibourtia coleosperma* (false mopane) is a valuable fruit tree in the area.

Figure 15. *Pterocarpus angolensis* (kiaat) have been heavily utilised in the past for timber production.
Figure 16. *Schinziophyton rautanenii* (manketti) ḑ protected ḑ is a valuable fruit tree in the area.

Figure 17. *Strychnos* species (monkey orange spp.) ḑ protected ḑ are valuable fruit trees throughout the area.

The most important larger tree and shrub species expected to occur in the general area include all those formally protected (See Tables 5 and 6) with the most important species viewed as *Baikiaea plurijuga*, *Burkea africana*, *Guibourtia coleosperma*, *Dialium engleranum*, *Philenoptera violacea*, *Pterocarpus angolensis*, *Schinziophyton rautanenii*, *Sclerocarya birrea* and *Strychnos* species (Figures 12-17). Of these, the most important species, classified as Lower Risk/Near Threatened by the IUCN (2020), are viewed as *Pterocarpus angolensis* (African teak or Kiaat) (De Cauwer et al. 2014) and *Baikiaea plurijuga* (Zambezi/Rhodesian Teak) due to numbers having decreased due to overutilization for wood production; elephant damage and unseasonal human induced fires (Figure 18-20).
Figure 18. Logging of *Baikiaea plurijuga* (Zambezi/Rhodesian Teak – Near Threatened, IUCN 2020) is evident throughout the area.

Figure 19. Many areas close to the various tracks and roads and along the Omuramba Omatako are clear cut for subsistence farming.
Figure 20. Unseasonal fires, usually started to stimulate grass growth for cattle or accidental fires when clearing land for cultivation, are destructive throughout the area.

The most important areas are viewed as the Omaramba Omatako; other Omuramba's and pans throughout the area (Figure 21-22).

Figure 21. The Omaramba Omatako is viewed as an important habitat in an otherwise flat and sandy environment.
The Omaramba Omatako is heavily impacted by human activity with fields being created within the drainage line and large numbers of cattle grazing the general areas. The most dominant tree and shrub species throughout the general area are *Burkea africana* (burkea) and *Terminalia sericea* (silver cluster leaf) (See Figures 5 and 6).

The general area has been heavily impacted in places, especially along the Omuramba Omatako and areas close to towns and settlements such as Rundu and Ncaute, etc., due to subsistence farming and logging activities. The protected species occur widespread throughout the general area and not exclusively associated with the seismic survey routes. The proposed mitigations - See Section 4 - are expected to minimise the overall effect on larger trees and shrubs potentially occurring in the area.

**Impact of ground seismic survey:**
A typical weight drop would have a peak force output of 860,000lbs (~430,000kg) at baseplate with an impulse frequency of 300Hz and a maximum cycle time of 10 seconds (Explorer 860 technical overview). Monk et al. (2004) indicates that although some compaction of the soil surface occurs, there is little or no long term damage to the surface. Although the precise impact of using this technology on trees/shrubs is unknown, disturbances would be of short duration and it is not expected that the ground seismic survey, using weight drop technology, will have any lasting negative impacts on trees/shrubs in the general area.

Habitat destruction, due to the creation and widening of new tracks, especially through the Omuramba Omatako (and other ephemeral drainage lines), is more important although the actual footprint is small. However, no new tracks are envisaged and all seismic activity will be conducted along existing roads and tracks throughout the area. This would thus not lead to additional habitat disturbances and increased access into areas currently not as easily accessible which could lead to increased slash-and-burn practices for agricultural purposes and increased harvesting (e.g. illegal logging) of valuable (and protected) tree species.

### 3.6 Grass Diversity

The grass diversity known and/or expected to occur in the general PEL 73 area (literature study only), including species confirmed during the fieldwork as well as the authors confirmed records during other studies from the general area, is presented in Table 7. This table indicates grass diversity along the various seismic routes.
It is estimated that at least 18-96 grasses (Müller 1984 [18sp.], Müller 2007 [43sp.], Van Oudshoorn 1999 [96sp.]) i.e. approximate total of 111 species i.e. occur in the general PEL 73 area.

The grasses known and/or expected to occur in the general area (¹Müller 2007, ²Van Oudshoorn 1999 and ³Müller 1984) is presented in Table 7 below.

**Table 7.** Grass diversity expected (literature study) and confirmed (fieldwork) along each of the seismic survey routes. The focus is on the inland area along the seismic routes and excludes species associated with the Okavango River. Species indicated are known from the quarter-degree square distribution principle used and don’t necessarily occur throughout the entire area. NS1/2/3 and EW1/2/3 = Seismic survey routes from north to south and east to west (See Figure 1).

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<th>Ecological Status</th>
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?  not classified in literature, but often similar to other species within the genus

### Source for literature review:  

Although up to 111 grasses are expected to occur in the general area, none of the 4 species of grasses endemic to Namibia is expected in the area (Müller 2007).

Except for the general ecological role of grasses (e.g. stabilising the soil, fodder/grazing value, etc.) none of the grasses are viewed as exceptionally unique in the area. The grasses commonly used for thatching ñ Eragrostis pallens and Cymbopogon species ñ which also have economic value, are the important grasses in the area.

During the fieldwork a total of 11 grasses were confirmed from the various seismic routes with the NS1 (10 spp.) and EW1 (6 spp.) routes having the highest number of species, respectively (See Table 7). Few grass species were confirmed from the area due to the rains having just started; large areas having been burnt and heavy grazing (overgrazing in places) pressure throughout (Figure 23).

The most dominant grass species throughout the general area are Aristida meridionalis (giant bristle-grass) and Eragrostis spp. ñ especially E. pallens (broom grass) (See Figures 15, 16, 21-22).

The general area has been heavily impacted in places, especially along the Omuramba Omatako and areas close to towns and settlements such as Rundu and Ncaute, etc., due to subsistence farming and heavy grazing pressure. None of the important species are exclusively associated with the seismic survey routes. The proposed mitigations ñ See Section 4 ñ are expected to minimise the overall effect on grass potentially occurring in the area.
Figure 23. Large herds of cattle and a continuous grazing system have resulted in large areas being denuded of grass and/or, together with unseasonal fires, impacted on the species diversity over time.

Impact of ground seismic survey:
A typical weight drop would have a peak force output of 860,000 lbs (~430,000 kg) at baseplate with an impulse frequency of 300 Hz and a maximum cycle time of 10 seconds (Explorer 860 technical overview). Monk et al. (2004) indicates that although some compaction of the soil surface occurs, there is little or no long term damage to the surface. Although the precise impact of using this technology on grasses is unknown, disturbances would be of short duration and it is not expected that the ground seismic survey, using weight drop technology, will have any lasting negative impacts on grasses in the general area.

Habitat destruction, due to the creation and widening of new tracks, especially through the Omuramba Omatako (and other ephemeral drainage lines), is more important although the actual footprint is small. However, no new tracks are envisaged and all seismic activity will be conducted along existing roads and tracks throughout the area. This would thus not lead to additional habitat disturbances and increased access into areas currently not as easily accessible which could lead to increased slash-and-burn practices for agricultural purposes; increased cattle numbers with added pressure on grasses.

3.7 Other Species

Other species
Aloes
All aloe species are protected in Namibia and thus viewed as important plants (Mendelsohn et al. 2002). Of the 27 Aloe species known from Namibia at least 2 other species not included in Table 5 (e.g. Aloe hereroensis and A. zebrina) occur on the periphery of the general area and may occur in the PEL 73 area (Rothman 2004). No Aloe spp. was observed throughout the area during the fieldwork.

Commiphora
Although many Commiphora species potentially occur throughout the area (Steyn 2003) some species (e.g. C. wildii) have economic potential (i.e. resin properties used in the perfume industry) making them potentially important (Knott and Curtis 2006). Other species potentially occurring in the general area (e.g. northeast Okavango River), but not listed in Table 5, include Commiphora karibensis and C. mossambicensis (Steyn 2003). Although a
few *Commiphora* spp. were observed during the fieldwork (See Tables 5 and 6) the above mentioned species were not.

**Ferns**

At least 64 species of ferns, of which 13 species being endemic, occur throughout Namibia. Ferns in the general area include at least 1 endemic species (*Marsilea villifolia*) and at least 6 indigenous species (*Isoetes alstonii, Marsilea ephippiocarpa, M. macrocarpa, M. nubica, M. vera, Ophioglossum polyphyllum*) (Crouch *et al.* 2011). The general area is undercollected with more species probably occurring in the area than presented above. No fern spp. was observed throughout the area during the fieldwork.

**Lichens**

The overall diversity of lichens is poorly known from Namibia, especially the coastal areas and statistics on endemicity is even sparser (Craven 1998). To indicate how poorly known lichens are from Namibia, the recent publication by Schultz *et al.* (2009) indicating that 37 of the 39 lichen species collected during BIOTO surveys in the early/mid 2000s were new to science (i.e. new species), is a case in point. More than 120 species are expected to occur in the Namib Desert with the majority being uniquely related to the coastal fog belt (Wirth 2010). Lichen diversity is related to air humidity and generally decreases inland from the Namibian coast (Schults and Rambold 2007). Many lichens look similar, are highly variable in appearance and notoriously difficult to identify unless with the use of a microscope (e.g. crustose lichens) or certain chemical tests. No lichen spp. was observed throughout the area during the fieldwork.

**Lithops**

No Lithops species (all protected: See Nature Conservation Ordinance No. 4 of 1975) are known to occur in the general area (Cole and Cole 2005).

Other species with commercial potential that could occur in the general area include *Citrullus lanatus* (Tsamma melon) and *Harpagophytum procumbens* (devil’s claw) which potentially have a huge economic benefit (Mendelsohn *et al.* 2002).

**Invasive alien species**

Invasive alien species observed during the fieldwork (See Tables 5 and 6) included: *Eucalyptus* spp. (Figure 24) *Opuntia* spp. (Figure 25) *Sisal* spp.

These species were usually associated with human settlements throughout the area i.e. along sections of the NS1 and EW1 seismic survey routes (See Tables 5 and 6).
Figure 24. *Eucalyptus* spp. (blue gum spp. See arrows) is an invasive alien plant species to Namibia and should be eradicated when encountered away from human settlements.

Figure 25. *Opuntia* spp. (prickly pear spp.) is an invasive alien plant species to Namibia and readily spread by birds and other mammals feeding on the palatable fruit. These should be eradicated when encountered away from human settlements.

### 3.8 Important Species

**Reptiles**

The most important species are viewed as the 2 endemics (*Ichnotropis grandiceps* and *Lygodactylus bradfieldi*), 3 species classified as rare (*Lycophidion multimaculatum*, *Psammophis jallae*, *Causus rhombeatus*) and 6 species classified as vulnerable (*Stigmochelys pardalis*, *Psammobates oculiferus*, *Kinixys spekii*, *Python natalensis*, *Varanus albigularis*, *Varanus niloticus*) from the general area. Furthermore, *Ichnotropis grandiceps*, is also classified as data deficient by the IUCN (2020), supporting its importance.
Amphibians
The most important species from the area is the giant bullfrog (*Pyxicephalus adspersus*) with population is decreasing according to the IUCN (2020) as it is consumed as food throughout its range.

Mammals
The most important species from the general area are probably those classified as rare (*Nycteris hispida*, *Kerivoula argentata*, *Kerivoula lanosa*, *Mastomys shortridgei*, *Civittictis civetta*, *Paracynictis selousi*) and endangered (*Lycaon pictus*, *Lutra maculicollis*, *Equus (burchellii) quagga*) under Namibian legislation and those classified by the IUCN (2020) as endangered (*Lycaon pictus*), vulnerable (*Loxodonta africana*, *Smutsia (Manis) temminckii*, *Acinonyx jubatus*, *Panthera pardus*, *Panthera leo*, *Hippopotamus amphibius*, *Giraffa camelopardalis*) and near threatened (*Hipposideros vittatus*). However, some of the above species e.g. other, hippo, etc. are only associated with the Okavango River. The most important species expected to occur in the general area would be the African wild dog (*Lycaon pictus*) and pangolin (*Smutsia (Manis) temminckii*).

Birds
The most important species are viewed as those classified as endangered (hooded vulture, white-backed vulture, tawny eagle, martial eagle, bateleur, southern ground-hornbill), vulnerable (secretarybird, white-headed vulture, lappet-faced vulture and) and near threatened (marabou stork, peregrine falcon, kori bustard) from Namibia (Simmons *et al.* 2015) as well as those classified by the IUCN (2020) as critically endangered (hooded vulture, white-headed vulture, white-backed vulture), endangered (lappet-faced vulture), 4 vulnerable (secretarybird, tawny eagle, martial eagle, southern ground-hornbill) and near threatened (bateleur, kori bustard).

Trees/shrubs
The most important species expected to occur in the general area are *Baikiaea plurijuga* (Protected F#; LR-nt; NT [IUCN 2020]), *Burkea africana* (Protected F#), *Guibourtia coleosperma* (Protected F#), *Dialium engleranum* (Protected F#), *Philenoptera violacea* (Protected F#), *Pterocarpus angolensis* (Protected F#; LR-nt), *Schinziophyton rautanenii* (Protected F#), *Sclerocarya birrea* (Protected F#) and various *Strychnos* species (Protected F#).

Grass
The grasses commonly used for thatching are *Eragrostis pallens* and *Cymbopogon* species which also have economic value, are the important grasses in the area.

3.9 Important Areas

The most important areas in the general area are:

1. Perennial Okavango River
The Okavango River is viewed as a site of special ecological importance in Namibia due to its biotic richness, threatened plants and insects (Curtis and Barnard 1998) (Figure 26).

2. Ephemeral Omuramba Omatako
Ephemeral rivers are viewed as sites of special ecological importance in Namibia due to its biotic richness, large mammals, high value for human subsistence and tourism (Curtis and Barnard 1998) (Figure 26).

3. Ephemeral Pans
Ephemeral pans are viewed as sites of special ecological importance in Namibia due to its biotic richness, endemic crustacean, Red Data birds, habitat and resource for humans and
wildlife (Curtis and Barnard 1998). Although important larger pans such as Nyae Nyae, etc. fall outside the general area, all other smaller pans are also viewed as important habitat.

4. Kaudum National Park
The Kaudum NP falls within the North-Eastern Kalahari Woodlands vegetation type with omurambas which act as ideal routes for wildlife. Dominant trees include: \textit{Acacia erioloba}, \textit{Adansonia digitata}, \textit{Baikiaea plurijuga}, \textit{Combretum imberbe}, \textit{Guibourtia coleosperma} and \textit{Spirostachys africana}. Important wildlife includes: African wild dog, leopard, lion, spotted hyaena, side-striped jackal, elephant, giraffe, blue wildebeest, eland, kudu, oryx, red hartebeest reedbuck, roan, tsessebe and warthog. Important birds include: Abdim's stork, African golden oriole, African hobby falcon, Bradfield's hombill, ground hornbill, lesser spotted eagle, racket-tailed roller, steppe eagle and yellow-billed kite (See: www.met.gov.na) (Figure 26).

5. Mangetti National Park
The Mangetti NP falls within the North-Eastern Kalahari Woodlands vegetation type with the vegetation on the dune crests markedly different to that in dune valleys i.e. Kalahari woodland vegetation dominates the dune crests, whereas mixed acacia savannah vegetation characterises the dune valleys. Dominant trees include: \textit{Acacia erioloba}, \textit{Acacia mellifera}, \textit{Combretum collinum}, \textit{Commiphora} species, \textit{Schinziophyton rautanenii} and \textit{Terminalia sericea}. Important wildlife includes: African wild cat, leopard, spotted hyaena, blue wildebeest, common duiker, kudu, oryx, sable, steenbok and occasional elephant and wild dog. Important birds include: bateleur, lapped-faced vulture, tawny eagle, Meyer's parrot and striped kingfisher (See: www.met.gov.na) (Figure 26).

6. Undisturbed areas
The general area is not pristine anymore due to prolonged human impact (e.g. settlements, slash-and-burn farming practices, unseasonal fires, etc.), especially along the perennial Okavango and ephemeral Omuramba Omatako Rivers, and more recently along the various tracks and roads throughout the area. However, there are some areas far from the rivers and tracks/roads which have less human impact (albeit not pristine), and viewed as more important. Creating new tracks in these areas would result in the destruction of numerous protected tree species as well as result in access to these areas leading to further settlements as well as illegal harvesting and poaching and overall environmental destruction. However, no new tracks/roads are envisaged as the seismic surveying will be conducted on existing access routes throughout the area.
4 Envisaged impacts

4.1 Introduction

All developments change or are destructive to the local fauna and flora to some or other degree. Assessing potential impacts is occasionally obvious, but more often difficult to predict accurately. Such predictions may change depending on the scope of the development i.e. development, once initiated, may have a different effect on the fauna and flora as originally predicted. Thus continuing monitoring of such impacts during the development phase(s) is imperative.

4.2 Faunal disturbance

Faunal disturbance with the proposed ground seismic activities would be localised. The following table indicates the potential/envisaged impacts expected regarding faunal disturbance (which is obviously closely linked to habitat destruction):

<table>
<thead>
<tr>
<th>Description</th>
<th>Faunal disturbance will vary depending on the scale/intensity of the seismic operations.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extent</td>
<td>1. Access routes (existing) - Localised disruption/destruction of the habitat and thus consequently fauna associated directly with the actual routes. This however, would be a relatively small area with localised implications.</td>
</tr>
<tr>
<td><strong>Duration</strong></td>
<td>1. Access route(s) - The duration of the impact is expected to be permanent along the route(s). This however, would be a relatively small area(s) with localised implications.</td>
</tr>
<tr>
<td>------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Intensity</strong></td>
<td>1. Access routes (existing) - The actual sites where expansion of the existing route(s) are envisaged would be permanently altered. This however, would be relatively small area(s) with localised implications. The areas adjacent the routes and other associated infrastructure should not be significantly affected. This however, would depend on control over the contractors during the road building/expansion phase(s), but should be limited to localised implications. Areas not directly affected by the routes (existing) although within the immediate area would be affected minimally. This would include dust, noise, light &amp; other associated disturbances in the area, but be limited to the road clearing and seismic activity periods.</td>
</tr>
<tr>
<td><strong>Mitigation</strong></td>
<td><strong>General</strong> 1. Limit the development to actual tracks/roads to be cleared and avoid affecting adjacent areas, especially the Omaramba Omatako and other ephemeral drainage lines and pans, throughout the entire area. 2. Avoid development &amp; associated infrastructure in sensitive areas i.e. e.g. Okavango River; Omaramba Omatako; other ephemeral drainage lines and pans and undeveloped areas (See 3.9). This would minimise the negative effect on the local environment especially unique features serving as habitat to various vertebrate fauna species. 3. Remove (e.g. capture) unique fauna and sensitive fauna (e.g. tortoises, monitor lizard) before commencing with the development activities and/or species serendipitously located during this period and relocate to undisturbed sites in the immediate area. 4. Prevent and discourage the setting of snares (poaching), illegal collecting of veld foods (e.g. tortoises, etc.), indiscriminate killing of perceived dangerous species (e.g. snakes, etc.) and collecting of wood as this would diminish and negatively affect the local fauna especially during the fieldwork phase(s). 5. Attempt to avoid the removal of bigger trees during the track clearing phase(s) as these serve as habitat for a myriad of fauna. Rather prune branches affecting access only. 6. Prevent and discourage fires especially during the track clearing phase(s) i.e. as this could easily cause runaway veld fires affecting the local fauna, but also causing problems (e.g. loss of grazing &amp; domestic stock mortalities, etc.) for the neighbouring communities. 7. Rehabilitation of the disturbed areas i.e. initial development access route scars and associated tracks as well as temporary camp sites. Preferably workers should be transported in/out to the track clearing sites on a daily basis to avoid excess damage to the local environment (e.g. fires, wood collection, poaching, etc.). Such rehabilitation would not only confirm the company’s environmental integrity, but also show true local commitment to the environment.</td>
</tr>
</tbody>
</table>
8. Prevent domestic pets i.e. cats & dogs i.e. accompanying the workers during the track clearing phase(s) as cats decimate the local fauna and interbreed & transmit diseases to the indigenous African wildcat found in the area. Dogs often cause problems when bonding on hunting expeditions thus negatively affecting the local fauna. The indiscriminate and wanton killing of the local fauna by such pets should be avoided at all costs.

9. Initiate a suitable waste removal system (i.e. remove to Rundu and not store on site) as this often attracts wildlife i.e. jackals, crows, etc. which may result in human-wildlife conflict issues.

10. Educate/inform contractors and staff on protected species (See Tables 1 to 4) to avoid and the consequences of illegal collection of such species.

11. Investigate the idea of employing an Environmental Officer during the track clearing phase(s) to ensure compliance and minimise the overall impact on the fauna and the environment.

12. Liaises with MET officials whilst working close to the Mangetti and Kaudum NPs.

**Tracks/Roads – General**

13. Avoid placing tracks/roads trough sensitive areas i.e. along ephemeral drainage lines and pans. Use existing access routes. This would minimise the effect on localised potentially sensitive habitats/fauna in the area.

14. Avoid felling protected tree species (especially large specimens and indigenous fruit trees i.e. follow a meandering approach which avoids such species rather than straight lines); avoid dead trees (habitat to a variety of cavity dwellers i.e. bats, geckos, hornbills, red-billed oxpeckers, etc.); avoid ephemeral pan areas; avoid vehicle activity within the ephemeral drainage lines, etc. as much as possible.

15. Prune overhanging branches, that may affect vehicle access, rather than removing the entire tree, especially for protected and fruit tree species.

16. Avoid driving randomly through the area (i.e. “track disciplined”), but rather stick to permanently placed tracks/roads. This would minimise the effect on localised potentially sensitive habitats/fauna in the area.

17. Stick to speed limits of maximum 30km/h as this would result in fewer faunal road mortalities. Lower speeds would also minimise dust pollution.

18. Implement erosion control. i.e. avoid constructing tracks within ephemeral drainage lines and pans; incorporate erosion furrows (runoff sites) and humps along tracks to channel water off the tracks to minimise erosion problems; cross drainage lines at right angles, etc. The area(s) towards & adjacent the drainage line(s) are easily eroded and further development may exacerbate this problem. Avoid construction within 100m of the main drainage line(s) to minimise erosion problems as well as preserving the riparian associated flora and fauna.

| Frequency of occurrence | Expected to be a one off issue affecting the selected site(s). Further prospecting & associated track/road construction and infrastructure developments (should this become necessary/evident during the prospecting operations) throughout the area would however increase the frequency of occurrence. |
Baseline study: Vertebrate Fauna & Flora - Cunningham

### Probability

<table>
<thead>
<tr>
<th>Probability</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definite (100%)</td>
<td>Negative impact on fauna is expected in the actual track/road construction areas. This however, would be much localised and cover only a small area(s) and should avoid sensitive areas.</td>
</tr>
<tr>
<td>Highly Probable (75%)</td>
<td>Negative impact on fauna is expected in the general areas especially during the construction phase(s) as a result of noise, increased activities, etc.</td>
</tr>
<tr>
<td>Probable (50%)</td>
<td>Negative impact on fauna is expected from the infrastructure (tracks/roads, etc.). Precautionary principle (e.g. avoid unique habitat features as well as adhering to the proposed mitigating measures would minimise this) would decrease the significance of these potential impacts.</td>
</tr>
</tbody>
</table>

### Significance

<table>
<thead>
<tr>
<th>Significance</th>
<th>Before mitigation:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>High</strong></td>
</tr>
<tr>
<td></td>
<td>After mitigation:</td>
</tr>
<tr>
<td></td>
<td><strong>Medium to Low</strong></td>
</tr>
</tbody>
</table>

### Status of the impact

<table>
<thead>
<tr>
<th>Status of the impact</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Localised unique habitats (e.g. Omaramba Omatako; other ephemeral drainage lines and pans; undisturbed areas) with associated fauna would bear the brunt of this proposed development, but be limited in extent and only permanent at the actual track/road development site(s).</td>
<td></td>
</tr>
</tbody>
</table>

### Legal requirements

<table>
<thead>
<tr>
<th>Legal requirements</th>
<th>Fauna related:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Nature Conservation Ordinance No. 4 of 1975, CITES, IUCN and SARDB Habitat</td>
</tr>
<tr>
<td></td>
<td>Flora related:</td>
</tr>
<tr>
<td></td>
<td>Forest Act No. 12 of 2001, Nature Conservation Ordinance No. 4 of 1975, CITES</td>
</tr>
</tbody>
</table>

### Degree of confidence in predictions

| Degree of confidence in predictions | As an ecologist I am sure of the above mentioned predictions made and would suggest that the mitigation measures be implemented to minimise potentially negative aspects regarding the local fauna in the area. |

### 4.3 Floral disturbance

Floral disturbance with the mining would be localised. The following table indicates the potential/envisaged impacts expected regarding floral disturbance (which is obviously closely linked to habitat destruction):

<table>
<thead>
<tr>
<th>Description</th>
<th>Floral disturbance will vary depending on the scale/intensity of the seismic operations.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Extent</th>
<th>1. Access routes (existing) - Localised disruption/destruction of the habitat and thus consequently fauna associated directly with the actual routes. This however, would be a relatively small area with localised implications.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>[No new tracks/roads will be created as seismic surveying will be conducted on existing access routes throughout the area]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Duration</th>
<th>1. Access route(s) - The duration of the impact is expected to be permanent along the route(s). This however, would be a relatively small area(s) with localised implications.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensity</td>
<td>Mitigation</td>
</tr>
<tr>
<td>-----------</td>
<td>------------</td>
</tr>
<tr>
<td>1. Access routes (existing) - The actual sites where expansion of the existing route(s) are envisaged would be permanently altered. This however, would be relatively small area(s) with localised implications.</td>
<td></td>
</tr>
<tr>
<td>The areas adjacent the routes and other associated infrastructure should not be significantly affected. This however, would depend on control over the contractors during the road building/expansion phase(s), but should be limited to localised implications.</td>
<td></td>
</tr>
<tr>
<td>Areas not directly affected by the routes (existing) although within the immediate area would be affected minimally. This would include dust &amp; other associated disturbances in the area, but be limited to the road clearing and seismic activity periods.</td>
<td></td>
</tr>
<tr>
<td>1. Limit the development to actual tracks/roads to be cleared and avoid affecting adjacent areas, especially the Omaramba Omatako and other ephemeral drainage lines and pans, throughout the entire area.</td>
<td></td>
</tr>
<tr>
<td>2. Avoid development &amp; associated infrastructure in sensitive areas e.g. Okavango River; Omaramba Omatako; other ephemeral drainage lines and pans and undeveloped areas (See 3.9). This would minimise the negative effect on the local environment especially unique features serving as habitat to various flora species.</td>
<td></td>
</tr>
<tr>
<td>3. Remove unique and sensitive flora (e.g. all Aloe spp., etc.) before commencing with the development activities and relocate to a less sensitive/disturbed site in the immediate area.</td>
<td></td>
</tr>
<tr>
<td>4. Prevent and discourage the collecting of firewood as dead wood has an important ecological role especially during the during the track/road building phase(s). Such collecting of firewood, especially for economic reasons, often leads to abuses e.g. chopping down of live and/or protected tree species such as Acacia erioloba, Burkea africana, etc. which are good quality wood.</td>
<td></td>
</tr>
<tr>
<td>5. Attempt to avoid the removal of bigger trees during the track/road clearing phase(s) as these serve as habitat for a myriad of fauna. Avoid the destruction of larger trees associated with the ephemeral drainage lines.</td>
<td></td>
</tr>
<tr>
<td>6. Prevent and discourage fires especially during the track/road clearing phase(s) as this could easily cause runaway veld fires causing problems (e.g. loss of grazing &amp; domestic stock mortalities, etc.) for the neighbouring communities.</td>
<td></td>
</tr>
<tr>
<td>7. Rehabilitation of the disturbed areas i.e. initial development access route “scars” and associated tracks as well as temporary camp sites. Preferably workers should be transported in/out to the track/road clearing sites on a daily basis to avoid excess damage to the local environment (e.g. fires, wood collection, poaching, etc.). Such rehabilitation would not only confirm the company’s environmental integrity, but also show true local commitment to the environment.</td>
<td></td>
</tr>
<tr>
<td>8. Eradicate destroy all invasive alien plants encountered on site e.g. Eucalyptus, Opuntia &amp; Sisal spp., etc. (See Tables 5 &amp; 6 for routes affected). This would ensure that the spread is limited and show environmental commitment.</td>
<td></td>
</tr>
<tr>
<td>9. Educate/inform contractors and staff on protected species (See Tables 5 &amp; 6 and Section 3.8) to avoid and the consequences of illegal collection of such species.</td>
<td></td>
</tr>
</tbody>
</table>
10. Investigate the idea of employing an Environmental Officer during the track/road building phase(s) to ensure compliance and minimise the overall impact on the flora and the environment.

11. Liaises with MET officials whilst working close to the Mangetti and Kaudum NPs.

### Tracks/Roads – General

12. Avoid placing tracks/roads through sensitive areas e.g. along ephemeral drainage lines and pans. Use existing access routes. This would minimise the effect on localised potentially sensitive habitats/fauna in the area.

13. Avoid felling protected tree species (especially large specimens and indigenous fruit trees i.e. follow a meandering approach which avoids such species rather than straight lines); avoid dead trees (habitat to a variety of cavity dwellers i.e. bats, geckos, hornbills, red-billed oxpeckers, etc.); avoid ephemeral pan areas; avoid vehicle activity within the ephemeral drainage lines, etc. as much as possible.

14. Prune overhanging branches, that may affect vehicle access, rather than removing the entire tree, especially for protected and fruit tree species.

15. Avoid driving randomly through the area (i.e. “track disciplined”), but rather stick to permanently placed tracks/roads. This would minimise the effect on localised potentially sensitive habitats/flora in the area.

16. Stick to speed limits of maximum 30km/h as this would result in less dust pollution.

17. Implement erosion control. i.e. avoid constructing tracks within ephemeral drainage lines and pans; incorporate erosion furrows (runoff sites) and humps along tracks to channel water off the tracks to minimise erosion problems; cross drainage lines at right angles, etc. The area(s) towards & adjacent the drainage line(s) are easily eroded and further development may exacerbate this problem. Avoid construction within 100m of the main drainage line(s) to minimise erosion problems as well as preserving the riparian associated flora and fauna.

### Frequency of occurrence

Expected to be a “once off” issue affecting the selected site(s). Further prospecting & associated track/road construction and infrastructure developments (should this become necessary/evident during the prospecting operations) throughout the area would however increase the frequency of occurrence.

### Probability

Definite (100%) negative impact on flora is expected in the actual track/road construction areas. This however, would be much localised and cover only a small area(s) and should avoid sensitive areas.

Highly Probable (75%) negative impact on flora is expected in the general areas especially during the construction phase(s) as a result of dust, increased activities, etc.

Probable (50%) negative impact on flora is expected from the infrastructure (tracks/roads, etc.). Precautionary principle (e.g. avoid unique habitat features as well as adhering to the proposed mitigating measures would minimise this) would decrease the significance of these potential impacts.
| Significance | Before mitigation: High  
| Status of the impact | After mitigation: Medium to Low |
| Localised unique habitats (e.g. Omaramba Omatako; other ephemeral drainage lines and pans; undisturbed areas) with associated flora would bear the brunt of this proposed development, but be limited in extent and only permanent at the actual track/road development site(s). |
| Legal requirements | Flora related: Forest Act No. 12 of 2001, Nature Conservation Ordinance No. 4 of 1975, CITES and IUCN  
| Habitat & Flora related: Forest Act No. 12 of 2001, Nature Conservation Ordinance No. 4 of 1975, CITES |
| Degree of confidence in predictions | As an ecologist I am sure of the above mentioned predictions made and would suggest that the mitigation measures be implemented to minimise potentially negative aspects regarding the local flora in the area. |

## 5 CONCLUSION

As all development have potential negative environmental consequences, identifying the most important faunal species including high risk habitats beforehand, coupled with environmentally acceptable mitigating factors, lessens the overall impact of such development.

It is estimated that at least 67 species of reptile, 32 amphibian, 116 mammal, 210 bird species (breeding residents), at least 107 species of larger trees and shrubs (>1m in height) and up to 111 species of grasses are known to or expected to occur in the general PEL 73 area. Although there are not as many endemic vertebrate fauna species in this area as in other parts of Namibia the wetland habitats and species associated with these habitats face numerous challenges due to the high density of humans along most of the river fronts. Wetland habitats in Namibia are not well protected and often have high human densities which place these areas under immense pressure. The over utilization of the fish, wood, reeds and grasses, unseasonal and too frequent fires, poaching, traditional medicine use as well as the high human densities and settlements along the river areas are some of the biggest problems facing the fauna in the Kavango Region. The rivers and floodplains are especially important habitat in north eastern Namibia.

The most important reptile species are viewed as the 2 endemics (*Ichnotropis grandiceps* and *Lygodactylus bradfieldii*), 3 species classified as rare (*Lycophidion multimaculatum, Psammophis jallae, Causus rhombeatus*) and 6 species classified as vulnerable (*Stigmochelys pardalis, Psammobates oculiferus, Kinixys spekii, Python natalensis, Varanus albigularis, Varanus niloticus*). The 2 species classified as data deficient by the IUCN (2020) — *Pelusios (bechuanicus) upembae* and *Ichnotropis grandiceps* — are also viewed as important although *P. upembae* would be associated with the Okavango River system only.

The most important species from the area is the giant bullfrog (*Pyxicephalus adspersus*) with population is decreasing according to the IUCN (2020) as it is consumed as food throughout its range. Most amphibians are expected to be associated with the Okavango River system in the area rather than the sandy interior, although the ephemeral Omuramba Omatako and pans throughout the general area would also be suitable habitat.
The most important species from the general area are probably those classified as rare (Nycteris hispida, Kerivoula argentata, Kerivoula lanosa, Mastomys shortridgei, Civiticitis civetta, Paracycinitis selousii) and endangered (Lycaon pictus, Lutra maculicollis, Equus (burchelli) quagga) under Namibian legislation and those classified by the IUCN (2020) as endangered (Lycaon pictus), vulnerable (Loxodonta africana, Smutsia (Manis) temminckii, Acinonyx jubatus, Panthera pardus, Panthera leo, Hippopotamus amphibious, Giraffa camelopardalis) and near threatened (Hipposideros vittatus, Aonyx capensis, Hydricitis (Lutra) maculicollis). However, some of the above species e.g. otter, hippo, etc. i are only associated with the Okavango River. The most important species expected to occur in the general area would be the African wild dog (Lycaon pictus) and pangolin (Smutsia (Manis) temminckii).

The most important species are viewed as those classified as endangered (hooded vulture, white-backed vulture, tawny eagle, martial eagle, bateleur, southern ground-hornbill), vulnerable (secretarybird, white-headed vulture, lappet-faced vulture and) and near threatened (marabou stork, peregrine falcon, kori bustard) from Namibia (Simmons et al. 2015) as well as those classified by the IUCN (2020) as critically endangered (hooded vulture, white-headed vulture, white-backed vulture), endangered (lappet-faced vulture), 4 vulnerable (secretarybird, tawny eagle, martial eagle, southern ground-hornbill) and near threatened (bateleur, kori bustard). An important species confirmed from the general area is the red-billed oxpecker and although their numbers have increased in communal areas in north-eastern Namibia, elsewhere they have been negatively affected due to arsenic-based cattle dips.

The most important larger tree/shrub species expected to occur in the general area are Baikiaea plurijuga (Protected F#; LR-nt; Near Threatened [IUCN 2020]), Burkea africana (Protected F#), Guibourtia coleosperma (Protected F#), Dialium engleranum (Protected F#), Philenoptera violacea (Protected F#), Pterocarpus angolensis (Protected F#; LR-nt), Schinziophyton rautanenii (Protected F#), Sclerocarya birrea (Protected F#) and Strychnos species (Protected F#). The most important grasses those commonly used for thatching i Eragrostis pallens and Cymbopogon species i.e. economic value. If herbs and flower- plants (e.g. algae, lichens, etc.) were to be included, this would undoubtedly increase the floral composition of the area tremendously i.e. more than 100 lichen species are known from coastal Namibia. Although, the focus for this desktop study was limited to the bigger and thus more obvious species of trees, shrubs and grasses, the importance other species such as lichens, ferns, Lithops, etc. is also acknowledged.

All human induced activities i including exploration activities i have potential negative environmental consequences, but identifying the most important fauna species including high risk habitats beforehand, coupled with environmentally acceptable recommendations (mitigating factors), lessens the overall impact of such activities. Should drilling activities be envisaged in future, fieldwork to determine the actual species affected/potentially affected on site is recommended.

It is not expected that the proposed ground seismic survey, using surface weight drop with the Explorer 860 truck as source unit, activities throughout the PEL 73 area will adversely affect any unique vertebrate fauna and flora, especially if the proposed recommendations (mitigation measures) are incorporated. However, new tracks/roads in currently undisturbed areas should be avoided as far as possible as numerous protected tree species (including indigenous fruit tree species) would be destroyed and furthermore, the tracks/roads would increase human access and settlements into the area, further exacerbating the overall environmental impacts. Although currently no new track/roads are to be created and existing access routes used only, should this not be possible, then the recommended mitigations should be followed to minimise the expected impacts (See Section 4).
REFERENCES


Hebbard, S. n.d. A close-up view of the Namib and some of its fascinating reptiles. ST Promotions, Swakopmund, Namibia.


Komen, L. n.d. The owls of Namibia. NARREC, Windhoek, Namibia.


3. Public and stakeholder consultation materials
4. CVs of the EAP and Specialist Consultants
Dr Sindila MWIYA
(PhD, MPhil/PG Cert, BEng (Hons), Pr. Eng)

SUMMARY OF QUALIFICATION

- Doctor of Philosophy (PhD) Engineering Geology/Geotechnical / Geoenvironmental / Environmental Engineering and Artificial Intelligence; Research Thesis: Development of a Knowledge-Based System Methodology (KBSM) for the Design of Solid Waste Disposal Sites in Arid and Semi-arid Environments (Namibia), University of Portsmouth, United Kingdom, 2003
- MPhil/PG Cert Engineering Geology/Geotechnical / Geoenvironmental / Environmental Engineering and Artificial Intelligence, University of Portsmouth, United Kingdom, 2000
- BEng (Hons) Engineering Geology and Geotechnics, University of Portsmouth in the United Kingdom, 1999.

Surname: MWIYA
Forename: SINDILA
Date and Place of Birth: 10 February 1971, Katima Mulilo, Namibia
Postal Address, Telephone and Email: P. O. Box 1839, WINDHOEK, NAMIBIA; Tel. + 264-61-306058; FaxMail: +264-886561821
Mobile: 264-81 141 3229; Email: smwiya@rbs.com.na

Professional Personal Profile

Dr Sindila Mwiya has more than eighteen (18) years of practical field-based technical industry experience in Environmental Assessment (SEA, EIA, EMP, EMS), Energy (Renewable and Non-renewable energy sources), onshore and offshore resources (minerals, oil, gas and water) exploration / prospecting, operation and utilisation, covering general and specialist technical exploration and recovery support. Health, Safety and Environment (HSE) permitting for Geophysical Surveys such as 2D, 3D and 4D Seismic, Gravity and Electromagnetic Surveys for mining, energy and petroleum (oil and gas) operations, support, through to engineering planning, layout, designing, logistical support, recovery, production / operations, compliance monitoring, rehabilitation, closure and aftercare projects lifecycles. He continues to work internationally in the resources (mining and petroleum) and energy sectors, from permitting through to exploration and production. From the frontier regions (high risk hydrocarbons exploration zones) of South Africa and Namibia, to the prolific oil and gas fields of the Middle East, Angola, Mozambique and the West African Gulf of Guinea, Dr Mwiya has been directly involved in field-based aerial, ground and marine geophysical (gravity, magnetics and seismic) surveys, been on-board exploration drilling rigs, onboard production platforms, conducted public and stakeholder consultations and engagements, and worked with highly technical and well organised and committed clients and third-party teams from emerging and well established global resources and energy companies from many countries such as the UK, France, USA, Russia, Canada, Croatia, Norway, the Netherlands, Spain, Brazil, China, South Africa, Equatorial Guinea, Angola and Nigeria. He is fully aware of all the competing interests and niche donation-based business environmental advocacy opportunism that exists in the resources sector from the local, regional and international perspectives.

Through his companies, Risk-Based Solutions (RBS) CC and Foresight Group Namibia (FGN) (Pty) Ltd which he founded, he has undertaken more than 200 projects for Local (Namibian), Continental (Africa) and International (Global) based clients. He has worked and continue to work for Global, Continental and Namibian based reputable resources (petroleum and mining / minerals) and energy companies such as Shell Namibia B. V. Limited (Namibia/ the Netherlands), Reconnaissance Energy Africa Ltd (ReconAfrica) (UK/Canada/Namibia), Dundee Precious Metals (Namibia / Canada), Headspring Investment (Namibia/ Russia), Green Mining (Namibia/UK/ Russia), EMGS (UK/ Norway), Lepidico (Australia / UK), Best Sheer / Bohale (Namibia / China), CGG Services UK Limited (UK/ France/Namibia), BW Offshore (Norway/Singapore /Namibia), Tullow Oil (UK/Namibia), Debmarine (DMBN) (Namibia), Osino Resource Corporation (Canada/USA/Namibia), Petrobras Oil and Gas (Brazil) / BP (UK)/ Namibia, REPSOL (Spain/ Namibia), ACREP (Namibia/Angola), Preview Energy Resources (UK), HRT Africa (Brazil / USA/ Namibia), Chariot Oil and Gas Exploration (UK/ Namibia), NABIRM (USA/ Namibia), Serica Energy (UK/ Namibia), Eco (Atlantic) Oil and Gas (Canada / USA/ Namibia), ION GeoVentures (USA), PGS UK Exploration (UK), TGS- Norpec (UK), Maurel & Prom (France / Namibia), Geopartners (UK), PetroSA Equatorial Guinea (South Africa / Equatorial Guinea/Namibia), Preview Energy Resources (Namibia / UK), Sintezneftegaz Namibia Ltd (Russia/Namibia), INA Namibia (INA INDUSTRIJA NAFTE d.d) (Croatia/ Namibia), Namibia Underwater Technologies (NUTAM) (South Africa/Namibia), InnoSun Holdings (Pty) Ltd and all renewable energy subsidiary companies and projects in Namibia (Namibia / France), HopSol (Namibia/Switzerland), Momentous Solar One (Pty) Ltd (Namibia / Canada), OLC Northern Sun Energy (Pty) Ltd (Namibia) and more than 100 local companies. Dr Sindila Mwiya is highly qualified with extensive practical field-based experience in petroleum, mining, renewable energy (Solar, Wind, Biomass, Geothermal and Hydropower), Non-Renewable energy (Coal, Petroleum, and Natural Gas), applied environmental assessment, management, and monitoring (Scoping, EIA, EMP, EMP, EMS) and overall industry specific HSE, cleaner production programmes, Geoenvironmental, geological and geotechnical engineering specialist fields.

Dr Sindila Mwiya has undertaken and continue to undertake and manage high value projects on behalf of global and local resources and energy companies. Currently, (2020-2023) Dr Sindila Mwiya is responsible for permitting planning through to...
operational and completion compliance monitoring, HSE and engineering technical support for multiple major upstream onshore and offshore petroleum, minerals and mining projects, Solar and Wind Energy Projects, manufacturing and environmentally sustainable, automated / smart and Climate Change resilient homes developments in different parts of the World including Namibia. He continue to worked as an International Resources Consultant, national Environmental Assessment Practitioner (EAP) / Environmentally Sustainable, automated / smart and Climate Change resilient homes developer, Engineering / Technical Consultant (RBS / FGN), Project Manager, Programme Advisor for the Department of Natural and Applied Sciences, Namibia University of Science and Technology (NUST) and has worked as a Lecturer, University of Namibia (UNAM), External Examiner/ Moderator, NUST, National (Namibia) Technical Advisor (Directorate of Environmental Affairs, Ministry of Environment, Forestry and Tourism / DANIDA i Cleaner Production Component) and Chief Geologist for Engineering and Environment Division, Geological Survey of Namibia, Ministry of Mines and Energy and a Field-Based Geotechnician (Specialised in Magnetics, Seismic, Gravity and Electromagnetics Exploration and Survey Methods) under the Federal Institute for Geoscience and Natural Resources (BGR) German Mineral Exploration Promotion Project to Namibia, Geophysics Division, Geological Survey of Namibia, Ministry of Mines and Energy.

He has supervised and continue to support a number of MScs and PhDs research programmes and has been a reviewer on international, national and regional researches, plans, programmes and projects with the objective to ensure substantial local skills development, pivotal to the national socioeconomic development through the promotion of sustainable natural resources coexistence, management, development, recovery, utilisation and for development policies, plans, programmes and projects financed by governments, private investors and Namibian development partners. Since 2006 until 2017, he has provided extensive technical support to the Department of Environmental Affairs (DEA), Ministry of Environment, Forestry and Tourism (MEFT) through GIZ in the preparation and amendments of the Namibian Environmental Management Act, 2007, (Act No. 7 of 2007), Strategic Environmental Assessment (SEA) Regulations, Environmental Impact Assessment (EIA) Regulations as well as the SEA and EIA Guidelines and Procedures all aimed at promoting effective environmental assessment and management practices in Namibia.

Among his academic achievements, Dr Sindila Mwiya is a holder of a PhD within the broader fields of Engineering Geology/Geotechnical / Geoenvironmental / Environmental Engineering and Artificial Intelligence with a research thesis titled Development of a Knowledge-Based System Methodology (KBSM) for the Design of Solid Waste Disposal Sites in Arid and Semiarid Environments, MPhil/PG Cert and BEng (Hons) (Engineering Geology and Geotechnics) qualifications from the University of Portsmouth, School of Earth and Environmental Sciences, United Kingdom. During the 2004 Namibia National Science Awards, organised by the Namibian Ministry of Education, and held in Windhoek, Dr Sindila Mwiya was awarded the Geologist of the Year for 2004, in the professional category. Furthermore, as part of his professional career recognition, Dr Sindila Mwiya is a life member of the Geological Society of Namibia, Consulting member of the Hydrogeological Society of Namibia and a Professional Engineer registered with the Engineering Council of Namibia.

**Skills and Experiences with more than 200 Consulting Projects undertaken 2004-2021**

Multidisciplinary Experienced PhD Degree-Qualified Professional Registered Engineer with the Engineering Council of Namibia specialised in the following:

- Energy (Fossil Fuels and Renewables)
- Mining (Mineral Exploration and Mining)
- Petroleum (Oil and gas Exploration and Production)
- Water Resources Exploration, Recovery and Sustainable Utilisation
- Development of Environmentally Sustainable, Automated / Smart and Climate Change resilient homes, housing, towns and cities
- Specialist skills in Environmental policy formulation, development and technical support
- Local, Regional, National, Bilateral and Multilateral Sectoral Projects, from Development to Management, Evaluation and Monitoring
- Pollution Prevention (P2) and Cleaner Production (CP) Programmes, from Development to Management, Evaluation and Monitoring
- Municipal and Mine Waste Streams and Systems Analysis
- Municipal and Mine Landfill / Waste Disposal Sites Development and Management
- Waste Management Minimum Requirements and Management Strategies
- Land Use Planning for Rural and Urban Regional and Local Government Developmental Plans, Projects, Programmes and Strategies
- Geological Technical Support Services to Large and Small Scale, Exploration, Mining and Oil Companies
- Ground Engineering Site Investigation [Geo-Engineering] for various Local, Regional and National Infrastructure Development Projects
- Water and Construction Materials Investigation, Evaluations, Development, Management and Monitoring
- Programmes and Strategies Management and Technical Support Services to Line Ministries, Regional Councils and Local Authorities
- Strategic Environmental Assessments -SEAs
- Environmental Impact Assessments - EIAs
- Environmental Management Plans EMPs
- Environmental Management Systems -EMSS
- Training and industry research in Waste Management, Applied Environment and Geo-Engineering fields
Educational Background

2000 - 2003 University of Portsmouth, UK: Doctor of Philosophy (PhD) in Engineering Geology /Geotechnical / Environmental Engineering (Geoenvironmental Engineering and Artificial Intelligence) - Research Title: Development of a Knowledge-Based System Model Methodology (KBSMM) for Design of Solid Waste Disposal Sites in Arid and Semiarid Environments with test sites covering all the Regions of Namibia

1999 - 2000 University of Portsmouth, UK: MPhil /Postgraduate Certificate in Scientific Research Methods (PG Cert)

1996 - 1999 University of Portsmouth, UK: BEng (Hons) Engineering Geology and Geotechnics (2/1, Upper Class) and Neil Duncan Special Award for best final year research project on Design of Kupferberg Landfill Site, Windhoek, Namibia

1995 - 1996 University of Portsmouth, UK: Advanced Certificate in Extended BEng (Hons)/ MEng Foundation year. Subjects studied are Mathematics (A+), Design (B), Electrical Science (A), Engineering Science (A), Engineering Material (A+) and Communication Skills (A).

1991 Seseke Secondary School: O-Level Certificate - Subjects studied: English language (B), Mathematics (A) Science (B) Geography (B), Biology (B), Silozi Language (B), Commerce (C) and Religious Education (C).

Employment / Contracts

<table>
<thead>
<tr>
<th>Year</th>
<th>Position</th>
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<tbody>
<tr>
<td>2004- Present</td>
<td>Founder and Technical Consultant with Risk-Based Solutions (RBS) CC and Foresight Group Namibia (FGN) (Pty) Ltd</td>
</tr>
<tr>
<td>2019-Present</td>
<td>Programme Advisor for the Department of Natural and Applied Sciences and External Examiner/Moderator-Namibia University of Science and Technology-NUST.</td>
</tr>
<tr>
<td>2000-2012</td>
<td>Part-time Lecturer, Faculty of Science, University of Namibia (UNAM) and External Examiner/Moderator-Namibia University of Science and Technology-NUST.</td>
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Selected Short-Term Specialised Courses

<table>
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<th>Year</th>
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<tr>
<td>February 2013</td>
<td>Offshore Survival, HUET and Firefighting, Cape Town South Africa</td>
</tr>
<tr>
<td>October 2003</td>
<td>Accelerated Leadership Masterlass, management course offered by the Centre for Management Studies, South Africa</td>
</tr>
<tr>
<td>May 2002</td>
<td>Mining and Coastal Environmental Assessment course offered by CSIR, South Africa.</td>
</tr>
<tr>
<td>November 2001</td>
<td>Paleoseismology in Seismic Hazard Assessment offered by the Association of Engineering Geologists, South Africa.</td>
</tr>
<tr>
<td>September 2000</td>
<td>Applied Environmental Economics offered by the European Commission, Windhoek, Namibia</td>
</tr>
<tr>
<td>January 2000</td>
<td>ER Mapper and GIS in natural resources management training offered by Geodass, Windhoek</td>
</tr>
</tbody>
</table>

Professional membership

- Registered Professional Engineers with the Engineering Council of Namibia (PE24016).
- Member of the Geological Society of Namibia
- Consulting member of the Hydrogeological Society of Namibia

Languages

- English: Excellent (Read, write and speak)
- Silozi and Subiya: mother tongue (Read, write and speak)
Selected Publications and Conference papers (20)

Environmental Assessment, Management and Monitoring related Projects Experiences: Undertaken more than 200 projects since 2004, including more than 55 oil and gas exploration and production related environmental assessments, management, and monitoring activities.

SELECTED CLIENT PORTFOLIO 2004 -2022
CURRICULUM VITAE

DR. VITA STANKEVICA (PhD, MSc, BSc)

SUMMARY OF QUALIFICATION

➢ Doctorate of Philosophy (PhD) (Geography), Development of Mining Settlements in Namibia: An Investigation into Prospects for Rosh Pinah; Klein Aub and Tsumeb, University of Namibia, 2015.
➢ Master of Sciences (MSc) in Geography (Regional Planning and Development), University of Latvia, 1997.
➢ Bachelor of Sciences (BSc) in Geography, University of Latvia, 1995.

PERSONAL DETAILS

Date of birth: 15th October, 1973
Nationality, Residence: Namibian Permanent Resident (Permit Nr. N 16536/2001)
Namibian ID No. 73101510279
Postal address: P. O. Box 1839, WINDHOEK, NAMIBIA
Contact details: Cell: +264-811413230; Tel. / Fax + 061 258113
E-mail: vstankevica@rbs.com.na
Driver's license: valid driver's licence (code C1E)

PERSONAL PROFILE

A co-founder of Risk-Based Solutions in 2004, Dr. Vita Stankevija has more than thirteen (13) years of professional direct industry experience in environmental assessment, management and monitoring support in sustainable resources utilisation and large, medium and small-scale infrastructural development activities in Namibia and SADC region. She has extensive knowledge in physical environment and its interaction with human activities with respect to current and future perspectives in environmental protection and sustainable natural resources utilisation. She has undertaken Scoping, Strategic Environmental Assessment (SEA) and Strategic Environmental Management Plan (SEMP) for policies, plans and programmes as well as site-specific support to large, medium and small scale project activities covering Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP). She is highly specialised in socioeconomic and sustainability assessments, performance, stakeholders engagements and compliance monitoring support for a sustainable people-centred rural and urban stability, growth and development, linked with the joint assistance of private-public local and regional development planning in an environment of global resources competition.

She has worked and continue to work for global reputable resources companies from UK, USA, Australia, Brazil, Canada, Spain, Israel, Croatia, Sweden, Angola, Equatorial Guinea and South Africa. She has worked as an Environmental Assessment Practitioner (EAP), Project Manager, Technical Consultant and Manager (RBS / FGN). Dr. Vita Stankevija is the GIS and environmental foresight of Risk-Based Based Solutions. She has extensive experience in programme management and administration with skills gained from the Risk-Based Based Solutions, Foresight Group Namibia, Global Environment Facility (GEF),

1 of 5 | P a g e
United Nations Development Programme (UNDP) and the World Bank project development and implementation processes. In all the policies, plans, programme and projects that she has undertaken Environmental Assessments (EA), Dr. Vita Stankevičiutė has brought together the context of local and regional rural and urban development planning to evolve sustainably together with the revitalisation integration of Namibia's resources industry in global markets.

Among her academic achievements, Dr. Vita Stankevičiutė has a PhD in Geography from the University of Namibia (Research Titled: Development of Mining Settlements in Namibia: An Investigation into Prospects for Rosh Pinah; Klein Aub and Tsumeb). Her research has identified possible solutions that could guide towards sustainable growth and development of mining settlements in Namibia. Furthermore, Dr. Vita Stankevičiutė holds a MSc degree in Geography ( Regional Planning and Development programme) and a BSc degree in Geography / programme in Physical Geography both from the University of Latvia. Dr. Vita Stankevičiutė has vast experience in both disciplines of geography (human and physical), excellent knowledge of physical environment and its processes, as well as its interaction with human activities. She hold great experience in stakeholders consultations and engagement process, coordination, collaboration and all centred on interpersonal and people skills.

SKILLS AND EXPERIENCE

- **Technical Knowledge**: Experience in resources (mining and petroleum industries), socioeconomic assessments, waste management, urban and rural related land use attributes / impacts and constraints investigation, management, monitoring and mitigation requirements
- **Programme Management and Administration**: broad experience in management and administration of different local and national projects, experience in working with different stakeholders (government, non-government organizations, CBOs, donors, international bodies, academics and general public), good organisational skills and time management
- **Urban and rural planning and development**: experience in preparation of different development plans for municipalities, extensive experience in urban socio-economic issues, deep understanding of environmental and social processes in urban areas, ability to think strategically, open toward new ideas
- **Organisation of workshops, seminars and meetings**: experience in organisation of workshops, seminars and meetings including international, preparation of logistics, reports and documents relevant to such activities
- **Computing**: excellent knowledge of personal computers and relevant software packages such as MS Office, Excel, Power Point, Publisher, ArcView and AutoCAD
- **Interpersonal skills**: responsible and initiative, good communication ability, easy to work in a team and multicultural environment.

EDUCATION

2015 Dr. Vita Stankevičiutė has a **PhD in Geography** from the University of Namibia (Research Titled: Development of Mining Settlements in Namibia: An Investigation into Prospects for Rosh Pinah; Klein Aub and Tsumeb)
1998  Post-graduate course in Perspectives of Environment and Sustainable Development in the Baltic Region
University of Kalmar, Department of Natural Sciences

1997  **MSc. degree** in Geography / Regional Planning and Development,
University of Latvia, Faculty of Geographical and Earth Sciences

1995  **BSc. degree** in Geography / Physical Geography
University of Latvia, Faculty of Geographical and Earth sciences

1991  Class of  Mathematics and Physics / Secondary School Nr.1 of Sigulda, Latvia

---

**SHORT COURSES AND TRAINING**

8-12 March, 2004  Chemical Information Exchange Network Training / by UNEP and USEPA. Safari Hotel, Windhoek

June 16-19, 2003  Workshop on National Execution Modality for UNDP-funded programmes. Heja Lodge, Namibia

April 3, 2003  Workshop on GEF Procedures and Country Level Coordination. Windhoek

March – April, 1999  Regional and Urban Planning
University of Barcelona, Spain

December, 1997  Teaching Sustainable Development and Agenda 21. The Baltic University; Teachers Training Seminar in Kazimierz Dolny, Poland

June-August, 1997  Energy planning and sustainable development.
University of Oslo, Norway

June, 1997  Modelling of the Specific and Sensitive Coastal Areas of the Baltic Sea. NorFA workshop in Vaasa, Finland

June-August, 1996  Urban ecology
Culture University 96 in Copenhagen, Denmark

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**EMPLOYMENT AND PRACTICAL EXPERIENCES**

<table>
<thead>
<tr>
<th>2004 - present</th>
<th>Management / Technical Consultant / Co-founder of Risk-Based Solutions cc. Project involved include local, national, regional (SADC) and global specialist technical support to the following areas:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>✓ Mining and Exploration</td>
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<td>✓ Petroleum (Oil and Gas)</td>
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<td></td>
<td>✓ Renewable Energy</td>
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<td>✓ Tourism development</td>
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<td>✓ Waste Management</td>
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<td>✓ Environmental Assessments (EIAs and SEAs)</td>
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<td></td>
<td>✓ Programme and Project Management and Logistics</td>
</tr>
<tr>
<td></td>
<td>✓ Specialised Training and Industry Research</td>
</tr>
<tr>
<td></td>
<td>✓ Investment opportunities</td>
</tr>
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</table>

2003 - 2004 (Sept) | Directorate of Environmental Affairs, MET, GEF Focal Point assistance, funded by World Bank and administered by the Namibia Nature Foundation (NNF)

1999 - 2003 | Freelance Consultant

1996 - 1999 | Laboratory of Regional Planning, Faculty of Geographical and Earth Sciences, University of Latvia. Senior technician

1997 - 1998 | Regional Studies Centre Ltd., Latvia. Research Assistant

1997 - 1998 | Department of Human Geography, Faculty of Geographical and Earth Sciences University of Latvia. Office Administrator

1994 - 1996 | Faculty of Geographical and Earth Sciences, University of Latvia. Secretary

PUBLICATIONS AND CONFERENCE PAPERS


LANGUAGE SKILLS

English - fluent
Russian - fluent
Latvian - fluent
French - intermediate
CURRICULUM VITAE

1. PERSONAL DATA
Name: DOCTOR ONJEFU, SYLVANUS AMEH
Sex: Male
Namibia Permanent Resident
Permit: 0010119000239
ID: 740123 10167
Home Address: Peneyambeko Flats, Gladiola Street, Khomasdal
Present Address: Faculty of Health and Applied Sciences
Namibia University of Science and Technology,
P/B 13388, Windhoek, Namibia
Telephone No.: +264814453306,
E-mail Address: jeffame39@gmail.com
Marital Status: Married

2. EDUCATIONAL INSTITUTIONS ATTENDED WITH DATES
a. North West University Mafikeng campus, South Africa 2013 - 2016
b. Federal University of Agriculture, Makurdi, Nigeria 2004 - 2006

3. ACADEMIC QUALIFICATIONS OBTAINED WITH DATES
a. PhD (Physics) 2016
b. MSc (Environmental Physics) 2006
c. BSc (Hons) Physics 2000
d. SSCE 1992

4. WORKING EXPERIENCE
POSITION AND ORGANISATION DATE
a. Lecturer, Department of Physics, College of Education 2002 - 2008
   Oju Benue State Nigeria
b. Lecturer, Department of Physics and Energy Studies 2008 - 2011
   Western Delta University, Oghara Delta State, Nigeria
c. RBS Environmental Health and Safety Consultant 2016 - Date

5. TEACHING EXPERIENCE
Courses Taught: Mechanics and Properties of Matter; Wave and Vibration; Environmental Physics; Health Physics; Electricity and Magnetism; Electrical Circuit & Electronics; Medical Physics; Radiation Physics; Statistical Physics; Thermal Physics; Mathematical method in Physics; Practical Physics; Optics; Modern Physics; Energy and Environment.

Students Supervision:

Honours -35


4. Mr Joshua Kaviyu Hindinwa (St. No. 215041585): Topic: Distribution and Dynamics of toxic heavy metals in cultivated farm produce from Tsumeb, Grootfontein and Otavi localities of Namibia. (NUST, October 2019) Completed.


10. Aune Remember Kapweya (St. No. 200935968): Assessment of desalinating efficiency of renewable and non-renewable energy operated desalination plants in Namibia. (NUST, In Progress).


14. PhD Supervision Current 1
6. PUBLICATIONS:


6. J. Abah, P Mashebe, S.A. Onjefu (2015). A114e112 e3g07| 031x2 e55/A|01x5eA0/0e(e,1H6eA Dietary Nitrate in Katima Mulilo, Namibia. IOSR Journal of Applied Chemistry. e-ISSN: 2278-5736. Vol 8, Issue 2 Ver. 11.


7. CONFERENCE PAPERS


27. Ambient Radiation Levels in Guma Salt Mine, Benue State, Nigeria; 29th Annual Conference of the Nigerian Institute of Physics (UNN, 2006).

28. Preliminary investigation of the Ambient Radiation Levels of Mine Sites in Benue State, Nigeria; 29th Annual Conference of the Nigerian Institute of Physics (UNN, 2006).

31. Measurement of Alpha Particle, Beta Particle and Gama Radiation in Mine Site in Jos Metropolis, 30th Annual Conference of the Nigerian Institute of Physics (LASU, 2007).
32. Variation of Noise Pollution Levels with time of the day in residential, commercial and industrial Areas in Otukpo Benue State, 30th Annual Conference of the Nigerian Institute of Physics (LASU, 2007).
33. Assessment of NORMs from salt mine along the coast of Erongo Region Namibia (FHAS 2015).
34. Measurement of Natural radionuclide distribution in sediment collected from Henties Bay beach Namibia. (FHAS Research week 2017).
37. Indoor Radon levels and the associated effective dose rate in selected buildings at the Namibia University of Science and Technology (NUST), Namibia (African Conference on Fundamental Physics; ACP 2018).

8. POSTER PRESENTATION

9. PLENARY OR KEYNOTE PRESENTATIONS
41. Beyond Credentialism: Empowering Namibian Youths For Self-Reliance Through Innovative Research (Key Presenter at the Research and Innovation Day of the University of Namibia Katima Mulilo Campus Windhoek 12 October 2016)

10. RESEARCH PROJECT
42. Honour Project: The effect of x-ray on electrical conductivity of Bovine tissue
43. MSc Thesis: Measurement of ambient radiation levels from mining sites in Benue State, Nigeria

11. Research Grant:
1. Institutional Research and Publication (NUST-2015): Amount: N$90,000

12. SERVICE TO UNIVERSITY / COMMUNITY
a. Curriculum development Physics. Namibia University of Science and Technology. 2011 Date.
e. Physical Science outreach program to Secondary Schools in Namibia. 2013 - Date
f. Tutoring IB Physics, Windhoek International School. 2013 - 2018
g. Curriculum review panel (Physics and Chemistry) NIED 2019
h. Namibian Institute for Educational Development 2019 to date

a. MEMBERSHIP OF PROFESSIONAL BODY
   Member Nigerian Institute of Physics (MNIP).

13. REFEREES:
a. Dr Sindila Mwiya
   Risk-Based Solutions (RBS) CC,
   Consulting Arm of Foresight Group Namibia
   (FGN) (Pty) Ltd
   Mobile: +264-811413229
   Email: smwiya@rbs.com.na
PETER CUNNINGHAM

EDUCATION

1996 University of Stellenbosch, South Africa
Masters of Science in Nature Conservation (MSc)
Â Financial support: De Beers Consolidated Mines & University of Stellenbosch.

1992 University of Stellenbosch, South Africa
Honours Bachelors of Science in Nature Conservation (BSc Hons)
Â Research project: Time Allocation and Spatial Distribution of Blesbok (Damaliscus dorcas phillipsi) and Springbok (Antidorcas marsupialis) on an Enclosed Area in the South Western Cape.

1989 University of Stellenbosch, South Africa
Bachelors of Science in Nature Conservation (BSc)

1982 De Aar High School, South Africa
Grade 12
Â Subjects: English First Language, Afrikaans First Language, Geography, Biology, Mathematics, and Accountancy.
Â Graduated with matriculation exemption.

OTHER QUALIFICATIONS

2001 University of Natal & Centre for Environmental Development, South Africa
Certificate in Wilderness Concepts and Practice (Basic Course)

2018 FSC Auditing to ISO19011 certificate
2018 FSC Forest Management certificate
Soil Association & Forest Stewardship Council (FSC)
EXPERIENCE: EMPLOYMENT

ECOLOGICAL CONSULTANT
Environment & Wildlife Consulting Namibia
YEARS EMPLOYED: JAN 2010 (ONGOING)
Windhoek, Namibia

- Self employed.
- Fauna & flora specialist reports for EIA’s, EPL’s & EMP’s.
- Environmental audits & formulation of environmental policies.
- Game ranch planning including management plans, determining wildlife numbers, stocking rates and carrying capacity.
- Forestry biomass estimates & harvesting recommendations.
- Develop & maintain environmental & wildlife monitoring programmes.
- Other duties include: administration, finances & budgeting.

SENIOR ECOLOGIST
Zoological Society of London (ZSL) & King Khalid Wildlife Research Centre (KKWRC)
YEARS EMPLOYED: JAN 2008-DEC 2009
Riyadh, Kingdom of Saudi Arabia

- Senior Ecologist.
- Responsible for research in protected areas managed by NCWCD (National Commission for Wildlife Conservation & Development) e.g. Mahazat as-Sayd, Uruq Bani Ma’Arid & Farasan Island for the ZSL (Zoological Society of London).
- Develop & maintain monitoring programmes, improve protected areas management.
- Collect data on ecosystem functioning, field surveys (habitat condition & game numbers).
- Other duties include: Departmental administration, finances, budgeting, acting director, labourer and wildlife management and general centre maintenance.

DEPUTY DIRECTOR/ASSOCIATE PROFESSOR
Polytechnic of Namibia
YEARS EMPLOYED: 2007
Windhoek, Namibia

- Head of Department & Co-ordinator: Bachelor of Technology (BTech) Nature Conservation.
- Curriculum development of the above mentioned courses.
- Other duties included: Departmental administration, finances & budgeting, applied research, practical demonstrations, student excursions, setting, marking & moderating papers.

SENIOR LECTURER
Polytechnic of Namibia
YEARS EMPLOYED: SEP 2001 TO DEC 2007
Windhoek, Namibia

- Curriculum development of the above mentioned courses.
- Other duties included: Departmental administration, finances & budgeting, applied research, practical demonstrations, student excursions, setting, marking & moderating papers.

CURATOR MAMMALS
Breeding Centre for Endangered Arabian Wildlife
YEARS EMPLOYED: 1998 TO 1999
Sharjah, United Arab Emirates

- Head of Department - Curator for mammals.
Ensured the provision and maintenance of habitat for all mammals.
Ensured the health, good nutrition and general well being of all mammals.
Provided and implemented solutions to enable the successful breeding of all endangered mammals.
Conducted applied research.

**LECTURER**
Polytechnic of Namibia

YEARS EMPLOYED: 1996 TO 1998

Lecturer.
Curriculum development of the above mentioned courses.
Other duties included: applied research, practical demonstrations, student excursions, setting & marking papers & assignments, moderating papers and taking minutes during Departmental meetings.

**TEMPORARY RESEARCH ASSISTANT**
University of Stellenbosch

YEARS EMPLOYED: 1994

Conducted research towards MSc degree on the Venetia Limpopo Nature Reserve, South Africa.

**GAME RANCH MANAGER**
Verdwaal Wildlife Sanctuary

YEARS EMPLOYED: 1989 TO 1990; 1992

Manager.
General farm management and overall maintenance of installations and equipment (e.g. vehicles, pumps, water installations, fences, roads, etc), culling of game, overall wildlife management, soil and vegetation management.

**ENVIRONMENTAL AWARDS**

   Individual contribution towards the conservation of the United Arab Emirates (UAE) environment and wildlife.

2. Certificate of recognition as Best Researcher in the School of Natural Resources & Tourism, Polytechnic of Namibia during the academic year 2002.

   In recognition of his numerous studies of Namibian fauna, most notably its reptiles, and also his work in training research students. His work in the popularisation of science is acknowledged; as editor of Roan News, as author of a variety of popular articles and in numerous lectures to the lay community.

**EXPERIENCE: ENVIRONMENTAL CONSULTING**
2021
- Zutari ñ MET Mast sites (Oranjemund area) ñ specialist report (Vertebrate Fauna & Flora).
- Excel Dynamics Solutions ñ EPL 7720 ñ base metals (Karibib) ñ specialist report (Vertebrate Fauna & Flora).
- Excel Dynamics Solutions ñ EPL 7874 ñ precious stones (Lüderitz) ñ specialist report (Vertebrate Fauna & Flora).
- NNF/NamPower ñ Ecology and flora associated with various southern Namibia transmission lines (Lüderitz-Namib; Lüderitz-Kolmanskop; Namib-E-Bay; Obib-Scorpion; Obib-Lorelei; Spitskop-Lorelei; Lorelei-Aurus; Aurus-Zincum; Zincum-Sendelings Drift; Lorelei-Orange River; Mariental-Hardap; Hardap-Stamriet; Stamriet-Aranos) specialist reports (Ecology & Flora).
- Environmental Compliance Consultancy ñ Osino Gold Project (Karibib) ñ specialist report (Vertebrate Fauna & Flora).

2020
- Risk-Based Solutions CC ñ PEL 73 Seismic Survey (Kavango East Area) ñ specialist report (Vertebrate Fauna & Flora).
- Environmental Compliance Consultancy ñ Farm Gai Kaisa No.159 Mechanical Harvesting Developments (Kombat) ñ specialist report (Vertebrate Fauna & Flora).
- Urban Green Town & Environmental Planning ñ Ongos 66kV transmission line (Windhoek area) ñ specialist report (Avifauna).
- Urban Green Town & Environmental Planning ñ Timbila Lodge Developments (Kalkveld area) ñ specialist report (Vertebrate Fauna, Flora & Ecology).
- NNF/NamPower ñ Presentations & Booklet ñ habitats and transmission lines (Habitats).
- Risk-Based Solutions CC ñ Uranium Project Wings: Leonardville Mine (Leonardville Area) ñ specialist report (Vertebrate Fauna & Flora).
- Risk-Based Solutions CC ñ Uranium Project Wings: Gobabis Sulphuric Acid Plant & Transmission Line (Gobabis/Lesmondville Area) ñ specialist report (Vertebrate Fauna & Flora).
- Deep Yellow/Reptile Uranium ñ Tumas Mining License (Swakopmund Area) ñ specialist report (Vertebrate Fauna).
- Risk-Based Solutions CC ñ Erongo Waste Disposal Site (Arandis Area) ñ specialist report (Vertebrate Fauna & Flora).
- Risk-Based Solutions CC ñ 66kV Desert Lion Transmission Line (Karibib Area) ñ specialist report (Vertebrate Fauna & Flora).

2019
- Soil Association/SABS ñ FSC Charcoal Audits ñ Carbo Namibia (Grootfontein, Tsumeb areas) as auditor/specialist (Woodland Management Issues).
- LM Consulting ñ Desert Fresh Foods (Pty) Ltd ñ Aquaponics Project (Swakopmund Area) ñ specialist report (Vertebrate Fauna & Flora).
- NNF/NamPower ñ Bush thickening problems associated with various Transmission lines (Gerus-Matemba, Gerus-Ombika, Gerus-Okahandja, Gerus-Oranjemund, Gerus-Parresis, Gerus-Platveld, Gerus-Welwitchia, Gerus-Zambezi, Gobabis-Krooster, Gobabis-Otjimbin; Windhoek-Naruchs; Windhoek-Kokerboom; Mariental-Gibeon; Mariental-Maltahohe; Omburu-Gerus; Omburu-Khan; Omburu-Marble; Omburu-Uis; Otjikoto-Berg Aukas; Otjikoto-Asis West; Rundu-Mahangu, Stamriet-Blattendorf, Welwichia-Kamanjab, Zambezi-Katima, Zambezi-HVDC) specialist reports (Flora & Herbicides).
- Knight Piésold ñ Meob Bay Tourism Development Project (Meob Bay area) ñ specialist report (Vertebrate Fauna & Flora).
- Urban Green Town & Environmental Planning ñ Kuiseb Delta Water Supply Project
2018

Â Aurecon ï ANNA (Angola-Namibia) 400KVa Powerline Project (Lubango-Ruacana) specialist report (Vertebrate Fauna & Flora).

Â Risk-Based Solutions CC ï Oranjemund Airport Upgrade (Oranjemund Area) ï specialist report (Vertebrate Fauna & Flora).

Â GIZ/FSC/NCA ï Namibian Standard for forest products development (National) specialist section (Ecology).

Â Aurecon ï ANNA (Angola-Namibia) 400KVa Powerline Project (Lubango-Ruacana) specialist report (Vertebrate Fauna & Flora).

Â Mutchler Consulting Services ï GET FiT Bush-To-Electricity Programme for Namibia (Tsumeb Area) ï specialist report (Vertebrate Fauna & Flora).

2017

Â Risk-Based Solutions CC ï Karibib Marble Mine ML/EPL 5536 (Karibib Area) ï specialist report (Vertebrate Fauna & Flora).

Â Nam-Geo Enviro Solutions ï ML24a (EPL4388) (Uis/Khorixas Area) ï specialist report (Vertebrate Fauna & Flora).

Â Risk-Based Solutions CC ï 132kV Powerline project between Whale Rock Cement Plant and Gerus Substation (Otjiwarongo Area) ï specialist report (Vertebrate Fauna & Flora).

Â Risk-Based Solutions CC ï ML82(a-f) Project - salt (Cape Cross Area) ï specialist report (Vertebrate Fauna & Flora).

Â Environmental Compliance Consultancy ï Okangwati Pipeline & Powerline Developments (Okangwati) ï specialist report (Vertebrate Fauna & Flora).

Â GIZ/FSC/NCA ï Namibian Standard for forest products development (National) specialist section (Ecology).

Â Urban Green Town & Environmental Planning ï Eastern National Water Carrier Powerlines (Waterberg area) ï specialist section (Ecology).

Â Aurecon ï Walvis Bay Waste Water Treatment Works (Walvis Bay/Dune 7 area) specialist report; pipeline & powerline issues (Vertebrate Fauna & Flora).

Â Urban Green Town & Environmental Planning ï EPL 5235 ï granite (Aus-Rosh Pinah area) ï specialist report (Vertebrate Fauna & Flora).

Â Risk-Based Solutions CC ï Helikon & Rubicon Lithium Project ï lithium (Karibib Area) ï specialist report (Vertebrate Fauna & Flora).

Â Aurecon ï Shepherd’s Lodge Powerline (Oranjemund) specialist report; vegetation & bird
management plans (Vertebrate Fauna & Flora)

South African Bureau of Standards (SABS) & Woodmark ñ FSC Charcoal Audits ñ Carbo Namibia, Friedheim Timbers, Jumbo Charcoal, Direct Charcoal (Grootfontein, Hochveld, Okahandja, Otjiwarongo areas) as auditor/specialist (Woodland Management Issues).

Risk-Based Solutions CC ñ EPL 6271 ñ precious stones (Lüderitz Area) ñ specialist report (Vertebrate Fauna & Flora).

Environmental Compliance Consultancy ñ Fibre Optic Cable Developments (Katima Mulilo to Ngoma) ñ specialist report (Vertebrate Fauna & Flora).


South African Bureau of Standards (SABS) & Woodmark ñ FSC Timber Audits ñ Merensky Timber, Limpopo, SAPPI Group & Main, Mpumalanga & KwaZulu Natal, TWK, Mpumalanga & Swaziland) as auditor/specialist (Plantation Management Issues).

Environmental Compliance Consultancy ñ Otjiwarongo Urban Developments (Extensions 10-15) (Otjiwarongo) ñ specialist report (Vertebrate Fauna & Flora).

Environmental Compliance Consultancy ñ Fibre Optic Cable Developments (Buitepos to Walvis Bay) ñ specialist report (Vertebrate Fauna & Flora).

Risk-Based Solutions CC ñ Bird Monitoring: E-Bay 150-500MW Wind Farm (Elizabeth Bay) ñ specialist report No 4 (Bird monitoring).

Risk-Based Solutions CC ñ EPLs 3738, 3739, 5117, 5196, 5439, 5649 (Karibib); EPL 5880 (Usakos) & EPL 5678 (Omaruru) (Karibib/Usakos/Omaruru Areas) ñ specialist report (Vertebrate Fauna & Flora).

Risk-Based Solutions CC ñ Whale Rock Cement Plant (Otjiwarongo Area) ñ specialist report (Vertebrate Fauna & Flora).

Gecko/SLR ñ Gecko Salt Aggregate Quarry (Wlotzakasbaken) ñ specialist report (Vertebrate Fauna & Flora).

Aurecon ñ Kalkveld Water Supply Extension (Kalkveld) specialist report (Pylon & Pipeline issues).

Risk-Based Solutions CC ñ WindNam 400kV Pylon (Rosh Pinah/Keetmanshoop to Elizabeth Bay) ñ specialist report (Vertebrate Fauna & Flora).

Risk-Based Solutions CC ñ Bird Monitoring: E-Bay 150-500MW Wind Farm (Elizabeth Bay) ñ specialist reports No5 1 to 3 (Bird monitoring).

South African Bureau of Standards (SABS) & Woodmark ñ FSC Charcoal Audits ñ Carbo Namibia; Direct Charcoal; Etosha Charcoal; Friedheim Timbers; Jumbo Charcoal & Makkara Charcoal (Gobabis, Grootfontein, Hochveld, Kalkveld, Okahandja, Otjiwarongo areas) as auditor/specialist (Woodland Management Issues).

Aurecon ñ Devils Fork to Collector 2 Reservoir Pipeline (Rooibank/Walvis Bay Area) specialist report (Vertebrate Fauna & Flora).

Risk-Based Solutions CC ñ E-Bay 150-500MW Wind Farm (Elizabeth Bay) ñ specialist report (Vertebrate Fauna & Flora).

Risk-Based Solutions CC ñ Namdeb 8-10MW Wind Farm (Elizabeth Bay) ñ specialist report (Vertebrate Fauna & Flora).

EcoCore Environmental Consultants ñ Kongola-Singoveka Water Supply Phase 3 (Kongola Area) ñ specialist report (Vertebrate Fauna & Flora).

South African Bureau of Standards (SABS) & Woodmark ñ FSC Timber Audit ñ (TWK Main & Group, Piet Retief, South Africa; Usutu Timber Products, Bunya, Swaziland) as auditor/specialist (Plantation Management Issues).

Aurecon ñ Kupferberg Landfill Development (Windhoek) specialist report (Vertebrate Fauna; Flora & Habitat survey).

Risk-Based Solutions CC ñ EPL 4590 prospecting (Maltahöhe Area) ñ specialist report (Vertebrate Fauna & Flora).

Risk-Based Solutions CC ñ EPL 4589 prospecting (Fransfontein Area) ñ specialist report (Vertebrate Fauna & Flora).

Urban Green Town & Environmental Planning ñ Farm Nordland Urban Developments (Otavi area) specialist section (Ecology).

2016

Aurecon ñ 10MW Wind Farm (Elizabeth Bay) ñ specialist report (Vertebrate Fauna & Flora).

Risk-Based Solutions CC ñ Bird Monitoring: E-Bay Wind Farm (Elizabeth Bay) ñ specialist report No 4 (Bird monitoring).

Risk-Based Solutions CC ñ Kupferberg Landfill Development (Windhoek) specialist report (Vertebrate Fauna; Flora & Habitat survey).

Risk-Based Solutions CC ñ FPL 4590 prospecting (Maltahöhe Area) ñ specialist report (Vertebrate Fauna & Flora).

Risk-Based Solutions CC ñ EPL 4589 prospecting (Fransfontein Area) ñ specialist report (Vertebrate Fauna & Flora).

Urban Green Town & Environmental Planning ñ Farm Nordland Urban Developments (Otavi area) specialist section (Ecology).

2015

South African Bureau of Standards (SABS) & Woodmark ñ FSC Charcoal Audits ñ Etosha
& Direct Charcoal (Outjo, Grootfontein & Otjiwarongo areas) as auditor/specialist (Woodland Management Issues).

- EcoCore Environmental Consultants (Rehoboth to Windhoek Commuter Train Service Route (Rehoboth-Windhoek)) as auditor/specialist (Vertebrate Fauna & Flora).

- South African Bureau of Standards (SABS) & Woodmark as auditor/specialist (Vertebrate Fauna & Flora).

- Urban Green Town & Environmental Planning (Leonardville) as auditor/specialist (EcoCore Environmental Consultants).

- Risk-Based Solutions CC as auditor/specialist (Risk-Based Solutions CC).

- South African Bureau of Standards (SABS) & Woodmark as auditor/specialist (Risk-Based Solutions CC).

- Urban Green Town & Environmental Planning as auditor/specialist (South African Bureau of Standards (SABS) & Woodmark).

- NamPower as auditor/specialist (NamPower).

- Urban Green Town & Environmental Planning as auditor/specialist (Urban Green Town & Environmental Planning).

- NamPower as auditor/specialist (NamPower).

- South African Bureau of Standards (SABS) & Woodmark as auditor/specialist (South African Bureau of Standards (SABS) & Woodmark).

- Africa Planning Forum CC as auditor/specialist (Africa Planning Forum CC).

- Risk-Based Solutions CC as auditor/specialist (Risk-Based Solutions CC).

- Africa Planning Forum CC as auditor/specialist (Africa Planning Forum CC).

- NamPower as auditor/specialist (NamPower).

- South African Bureau of Standards (SABS) & Woodmark as auditor/specialist (South African Bureau of Standards (SABS) & Woodmark).

- Urban Green Town & Environmental Planning as auditor/specialist (Urban Green Town & Environmental Planning).

- Risk-Based Solutions CC as auditor/specialist (Risk-Based Solutions CC).

- Turnix Environmental Consulting CC as auditor/specialist (Turnix Environmental Consulting CC).

- Risk-Based Solutions CC as auditor/specialist (Risk-Based Solutions CC).

- Aurecon as auditor/specialist (Aurecon).
Fauna & Flora
Á ERM (Environmental Resources Management Pty (Ltd) Southern Africa) į Baynes Hydropower Project: Linear and Associated Infrastructure (Walvis Bay to Baynes Dam area) (Biophysical Issues).
Á South African Bureau of Standards (SABS) & Woodmark į FSC Charcoal Audits į Direct; Friedheim & Etosha Charcoal (Grootfontein; Hochveld; Otjiwarongo & Outjo areas) as auditor/specialist (Woodland Management Issues).
Á South African Bureau of Standards (SABS) & Woodmark į FSC Timber Audit (BedRock, Tzaneen; Masonite, Pietermaritzburg; TWK, Piet Retief į South Africa) as auditor/specialist (Plantation Management Issues).
Á Aurecon į Amas-Karasburg Transfer Pipeline Project (Karasburg area) specialist report (Vertebrate Fauna & Flora)
Á Risk-Based Solutions CC į Tobacco & Maize Developments (Katima Mulilo area) į specialist report (Vertebrate Fauna & Flora).
Á Aurecon į Swakopmund Base Station to C14 Pipeline; Eastern Route (Swakopmund-Walvis Bay) specialist report (Vertebrate Fauna & Flora)
Á Urban Green Town į Environment Planning į Oranjemund Quarry Sites A & B (Oranjemund) specialist report (Vertebrate Fauna & Flora; Construction & Operational Management Plan; Rehabilitation Plan).
Á NEHC (National Environmental Health Consultants) į Desert Rose Urban Development (Swakopmund-Walvis Bay Area) (Vertebrate Fauna & Flora).
Á LM Environmental Consulting į Eiseb River EPL į 4640, 4641, 4642, 4644 & 4646 (Otjinene Area) specialist report (Vertebrate Fauna & Flora)
Á Risk-Based Solutions CC į Luderitz Wind Farms į Penguin & Seal (Luderitz area) į specialist report (Vertebrate Fauna & Flora).
Á Risk-Based Solutions CC į Lorelei EPL į 4234 (Rosh Pinah area) į specialist report (Vertebrate Fauna & Flora).
Á EcoCore Environmental Consultants į Omuthiya to Ongwediva Road Upgrade (Oshakati area) specialist report (Vegetation Assessment)
Á South African Bureau of Standards (SABS) & Woodmark į FSC Timber Audit (Sappi; Piet Retief area, South Africa) as auditor/specialist (Plantation Management Issues).
Á South African Bureau of Standards (SABS) & Woodmark į FSC Charcoal Audit (Grootfontein, Otjiwarongo areas) as auditor/local specialist (Woodland Management Issues).
Á Aurecon į Solar PV project (Gross Barmen; Mariental & Omaruru areas) specialist report (Vertebrate Fauna & Flora)
Á Risk-Based Solutions CC į LAM TM470 Flight wreckage recovery operation (Bwabwata NP area) į specialist report (Vertebrate Fauna & Flora).
Á Aurecon į Swakopmund to Mile 7 Water Supply Phase 2 (Swakopmund-Walvis Bay) specialist report (Vertebrate Fauna & Flora)
Á EcoCore Environmental Consultants į Okahao Township Developments (Okahao) specialist report (Vertebrate Fauna & Flora)

2013
Á Marenica Energy Namibia į Review of Environmental Reports (Spitzkoppe area) į status report (Environmental & Status Report)
Á Risk-Based Solutions CC į Solar Power Plant (Gross Barmen area) į specialist report & site visit (Vertebrate Fauna & Flora).
Á Aurecon į Orange Falls Hydro Electric Power (Onsepkans area) į specialist report (Vertebrate Fauna & Flora)
Á Namdeb į Aris Drif & Auchas Lower (Oranjemund area) į vertebrate fauna baseline survey (Vertebrate Fauna).
Á EcoCore Environmental Consultants į Oshikuku Township Developments (Oshikuku) specialist report (Vertebrate Fauna & Flora)
Á South African Bureau of Standards (SABS) & Woodmark į FSC Forestry Audit (Hazuyview & White River areas į Bedrock Fiber Resources, South Africa) as environmental auditor (Plantation Management Issues).
Á South African Bureau of Standards (SABS) & Woodmark į FSC Charcoal Audit (Hochveld, Otjiwarongo, Outjo, Tsumeb areas) as auditor/local specialist (Woodland Management Issues).
Issues).

- Risk-Based Solutions CC ī Karibib Lithium (Karibib area) specialist report (Vertebrate Fauna & Flora).
- Risk-Based Solutions CC ī EPL's 4323 & 4324 (Conception to St Francis Bay area) specialist report (Vertebrate Fauna & Flora).
- Urban Green Town & Environmental Planning ī Various MTC BTS Towers (Kapansi; Mata-Mata; Omatako Valley, Onawa; Onkombula; Otjiyarwa) specialist reports (Vertebrate Fauna & Flora).
- CENR CC ī Mudumu Solid Waste Disposal Site (Caprivi) specialist report (Vertebrate Fauna & Flora).
- Risk-Based Solutions CC ī EPL 4688 (Witvlei area) specialist report (Vertebrate Fauna & Flora).
- Risk-Based Solutions CC ī EPL 4742 (Dobra/Brakwater area) specialist report (Vertebrate Fauna & Flora).
- NamPower ī Bush thickening problems associated with various Transmission lines (Van Eck-Omburu 1 & 2; Auas-Omaere; Gerus-Otjikoto & Aranos/Stampriet area) specialist reports (Flora & Herbicides).
- LM Environmental Consulting ī Otiosoondo EPL 4704 (Manganese) Prospecting (Hochveld Area) vegetation & habitat assessment (Flora).
- Risk-Based Solutions CC ī Elbe EPL 4232 (Zinc/Copper/Gold/Lead) (Okahandja Area) specialist report (Vertebrate Fauna & Flora).
- Namdeb ī Karingarab EPL 3749 (Rare Earth Elements) (Oranjemund area) ī vertebrate fauna baseline survey (Vertebrate Fauna).
- SLR ī Walvis Bay Salt Works extension (Walvis Bay) avifauna specialist report (Avifauna).
- Urban Green Town & Environmental Planning ī Aus Sewerage Works Project (Aus) site assessment (Flora) and specialist report (Vertebrate Fauna & Flora).
- Urban Green Town & Environmental Planning ī Ujams Sewerage Works Project (Windhoek) site assessment & pre-construction report (Flora).
- Enviro Management Consultants Namibia (EMC Namibia) ī Groostfontein-Otjihene Road Link Project (eastern Namibia) specialist report (Vertebrate Fauna & Flora).
- EnviroSolutions ī Erongo Red Power Lines - Walmund (Swakopmund Area) specialist report (Vertebrate Fauna & Flora).
- Aurecon ī Kalkveld Water Supply Extension (Kalkveld Area) specialist report (Vertebrate Fauna & Flora).
- Softchem & Reptile Uranium Namibia ī EPL Ongolo & Tumas (Uranium) mining development (Swakopmund area) specialist report (Vertebrate Fauna & Flora).

2012

- LM Environmental Consulting ī Otiosoondo EPL 4704 (Manganese) Prospecting (Hochveld Area) specialist report (Vertebrate Fauna & Flora).
- Risk-Based Solutions CC ī Key Fauna & Flora in Protected Areas Network, Namibia (Namibia) specialist report (Key Vertebrate Fauna & Flora spp.).
- Namdeb ī Reptile & Small Mammal Capture & Relocation Operation (Sendelingsdrift area) (Capture & Removal).
- Elmarie Du Toit Town Planning Consultant ī Baumgartshbrunn Township Development (Windhoek Area) specialist report (Vertebrate Fauna & Flora).
- Risk-Based Solutions CC ī Rainbow Salt Works (Wlotzkasbaken Area) specialist report (Vertebrate Fauna & Flora).
- NamPower ī Kunene Transmission Substation Development (Ruacana area) specialist report (Vertebrate Fauna & Flora).
- South African Bureau of Standards (SABS) & Woodmark ī FSC Charcoal Audit (Groostfontein, Hochveld, Otjiwarongo & Outjo areas) as auditor/local specialist (Woodland Management Issues).
- Enviro Management Consultants Namibia (EMC Namibia) ī Aus/Bethanie-Solitaire-
Walvis Bay Road Link Project (western Namibia) specialist report (Vertebrate Fauna & Flora).

- Urban Green Town & Environmental Planning in Namibian Crocodile Project (Kongola, Caprivi) specialist report (Vertebrate Fauna & Flora).

- Urban Green Town & Environmental Planning in Bowker Hill MTC developments & CEMP (Windhoek area) specialist report (Site assessment; construction monitoring; Construction EMP [CEMP]; Rehabilitation Management & Monitoring Plans).

- Risk-Based Solutions CC in Solar Power Plants (Keetmanshoop, Mariental & Omaruru areas) specialist report & site visit (Vertebrate Fauna & Flora).

- South African Bureau of Standards (SABS) & Woodmark in FSC closeout Audit (Okahandja area) as auditor/local specialist (Woodland Management Issues).

- Urban Green Town & Environmental Planning in Flora & Flora areas as Flora & Flora specialist report (Status Report).

- Caprivi Parks Consultants (CPC) & MET in Design & present a Savannah Ecology Training Course for MET staff (Northeast Parks) (Ecology Course).

- Urban Green Town & Environmental Planning in Erf Re 3/2/49 Farm Dobra rezoning: residential to industrial - Brakwater (Windhoek area) specialist report (Flora).


- Risk-Based Solutions CC in Coal Bed Methane (CBM) Prospecting in Block 2114 (Huab Basin) specialist report (Vertebrate Fauna & Flora).

- Risk-Based Solutions CC in Diaz Point Phosphate Plant (Lüderitz) specialist report (Vertebrate Fauna & Flora).

- Strengthening Protected Areas Namibia (SPAN) & Ministry of Environment & Tourism (MET) in Alignment & completion of Park Management Plans (Sperrgebied, Waterberg, /Ai-/Ais & Mangetti National Parks) (Management Plans).

- Risk-Based Solutions CC in Lüderitz Basin Offshore Exploration (petroleum) (Lüderitz to Walvis Bay area) specialist report (Vertebrate Fauna & Flora).

- Risk-Based Solutions CC in Orange Basin Offshore Exploration (petroleum) (Oranjemund to Lüderitz area) specialist report (Vertebrate Fauna & Flora).

2011

- South African Bureau of Standards (SABS) & Woodmark in FSC Charcoal Audit (Outjo, Otjiwarongo, Tsumeb areas) as auditor/local specialist (Woodland Management Issues).

- Risk-Based Solutions CC in Khorixas EPL 4174 (copper & iron) (Khorixas area) specialist report (Vertebrate Fauna & Flora).

- Urban Green Town & Environmental Planning in Sewerage Works (Omitara & Warmbad) specialist report (Vertebrate Fauna & Flora).

- Urban Green Town & Environmental Planning in Flora & Flora areas as Flora & Flora specialist report (Status Report).

- Risk-Based Solutions CC in Lüderitz Phosphate Plant (Lüderitz) specialist report (Vertebrate Fauna & Flora).

- Urban Green Town & Environmental Planning in Lodge & Nature Estate developments (Kamanjab area) specialist report (Vertebrate Fauna & Flora).

- Risk-Based Solutions CC in Wlotzkasbaken Salt Works (Wlotzkasbaken area) specialist report (Vertebrate Fauna & Flora).

- Risk-Based Solutions CC in Coastal/Offshore Block 1811 (oil & gas) prospecting (Angra Fria area) specialist report (Vertebrate Fauna & Flora).

- Risk-Based Solutions CC in Aus EPL 4425 (dimension stone) mining development (Aus area) specialist report (Vertebrate Fauna & Flora).

- Enviro Dynamics & Namwater in Swakop South Pipeline (Swakopmund area) (Vertebrate Fauna Movement).

- University Central Consultancy Bureau (UCCB) in Tourism development in the Kuiseb Delta and Dune Belt area (Walvis Bay & Swakopmund areas) specialist report (Vertebrate Fauna & Flora).


- Enviro Dynamics in NBC Towers site location effect on amphibians, reptiles & mammals
(throughout Namibia) (Sensitivity Ratings).

Â Urban Green Town & Environmental Planning ľ MR 125 road upgrading between Kongola-Liselo-Singalamwe (Caprivi region) specialist report (Vertebrate Fauna & Flora).

Â Urban Green Town & Environmental Planning ľ Daan Viljoen Game Park luxury suites (Windhoek) specialist report (Flora).

Â Urban Green Town & Environmental Planning ľ Amusement Park (Windhoek) specialist report (Vertebrate Fauna & Flora).

Â Urban Green Town & Environmental Planning ľ Erf Re 137/48 rezoning: residential to industrial - Brakwater (Windhoek area) specialist report (Flora).

Â Urban Green Town & Environmental Planning ľ Erf Re 13/48 rezoning: residential to industrial - Brakwater (Windhoek area) specialist report (Flora).

Â Urban Green Town & Environmental Planning ľ Erf Re 486 subdivision ľ Kapps Farm (Windhoek area) specialist report (Flora).

Â Urban Green Town & Environmental Planning ľ Otjimbingwe water/pipeline provision (Otjimbingwe) specialist report (Vertebrate Fauna & Flora).

Â Urban Green Town & Environmental Planning ľ Erf Re 35 rezoning: residential to industrial - Brakwater (Windhoek area) specialist report (Flora).

Â Geo Pollution Technologies ľ EPL (gas & oil) mining development (Huab Block - Damaraland) specialist report (Vertebrate Fauna & Flora).

Â Enviro Dynamics & Navachab Gold Mine ľ Navachab Biodiversity Inventory (Karibib) (Vertebrate Fauna).

2010

Â Urban Green Town & Environmental Planning ľ MTC Hoffnung cell phone tower (Windhoek area) specialist report (Vertebrate Fauna & Flora).

Â NEMRU, Gobabeb & Swakop Uranium ľ Rapid habitat and basic ecological assessment of the Husab Sand Lizard (Pedioplanis husabensis) at the Husab Uranium Mine (Swakopmund area) (Reptile study).

Â Risk-Based Solutions CC ľ Mwale Mwiya Park urban development (Katima Mulilo) specialist report (Vertebrate Fauna & Flora).

Â Risk-Based Solutions CC ľ Zhonghe EPL (uranium) mining development (Arandis/Swakopmund area) specialist report (Vertebrate Fauna & Flora).

Â Risk-Based Solutions CC ľ EPL (gold) mining development (Okahandja/Gross Barmen area) specialist report (Vertebrate Fauna & Flora).


Â Geo Pollution Technologies ľ SABMiller breweries development (Okahandja) specialist report (Flora).

Â Softchem & Reptile Uranium Namibia ľ EPL (uranium) mining development (Swakopmund area) specialist report (Vertebrate Fauna & Flora).

Â Risk-Based Solutions CC ľ EPL (copper) mining development (Rehoboth area) specialist report (Vertebrate Fauna & Flora).

Â LM Environmental Consulting & International Development Consultancy (IDC) ľ Housing development ľ Finkenstein (Windhoek) specialist report (Vertebrate Fauna & Flora).

Â Risk-Based Solutions CC ľ EPL (semi precious stones) mining development (Brandberg area) specialist report (Vertebrate Fauna & Flora).

Â Risk-Based Solutions CC ľ EPL (copper) mining development (Rosh Pinah area) specialist report (Vertebrate Fauna & Flora).

Â ERM & Enviro Dynamics ľ Baynes Hydroelectric Dam project (Epupa area) specialist report (Small Mammals & Avifauna).

Â CSIR & Enviro Dynamics ľ Sendelingsdrif diamond mining, Namdeb (Oranjemund area) specialist report (Reptiles & Small Mammals).

Â SGS ľ CCF Bushbloc audit (Otjiwarongo area) as auditor/specialist (Woodland management issues).

Â Urban Green Town & Environmental Planning ľ Goreangab Waterfront development (Goreangab Dam - Windhoek area) specialist report (Vertebrate Fauna & Flora).

Â Risk-Based Solutions CC ľ Wind Energy Facility development (Walvis Bay area) specialist report (Vertebrate Fauna & Flora).
report (Vertebrate Fauna & Flora).

Â Urban Green Town & Environmental Planning on: Site monitoring of biophysical issues (Monitoring & Rehabilitation) for MTC cell phone towers in Windhoek.

Â Urban Green Town & Environmental Planning on: Water Treatment Plant development (Ujams - Windhoek area) specialist report (Vertebrate Fauna & Flora).

2009

Â Enviro Dynamics Ė Amphibian, reptile & mammal biodiversity in Windhoek for City of Windhoek: specialist report, literature review (Fauna).

Â Urban Green Town & Environmental Planning on: Biophysical issues (Vertebrate Fauna & Flora) & Namatanga Conservancy issues for SUNGATE Development, Windhoek Area.

Â Urban Green Town & Environmental Planning on: Rapid Assessment: Biophysical issues (Vertebrate Fauna & Flora) for King Nahale Gate Lodge, Etosha National Park area.

Â Risk-Based Solutions CC Ė Glass factory development (Rehoboth area) literature review (Vertebrate Fauna & Flora).

Â Risk-Based Solutions CC Ė Small mining development (Karibib area) literature review (Vertebrate Fauna & Flora).

Â Risk-Based Solutions CC Ė Clay-Pottery development (Kavango River area) literature review (Vertebrate Fauna & Flora).

Â Risk-Based Solutions CC Ė Clay-Pottery development (Zambezi River area) literature review (Vertebrate Fauna & Flora).

Â Urban Green Town & Environmental Planning on: Rapid Assessment: Biophysical issues (Vertebrate Fauna & Flora) for MTC cell phone towers in Windhoek.

2008

Â Urban Green Town & Environmental Planning on: Rapid Assessment: Biophysical issues (Vertebrate Fauna & Flora) for the Farm Detmont urban development, Windhoek (Khomas Hochland) Area.

Â Urban Green Town & Environmental Planning on: Rapid Assessment: Biophysical issues (Vertebrate Fauna & Flora) for the Farm Sonnleiten urban development, Windhoek (Khomas Hochland) Area.


2007

Â Risk-Based Solutions CC Ė Copper Deposits in central western Namibia (Klein Aub area) literature review (Vertebrate Fauna & Flora).

Â Risk-Based Solutions CC Ė Supply Base & Landfill Site (Walvis Bay area) literature review (Vertebrate Fauna & Flora).

Â Risk-Based Solutions CC Ė Oil Exploration (Kunene River Mouth area) literature review (Vertebrate Fauna & Flora).


Â Risk-Based Solutions CC Ė Base Metal Exploration (Goageb/Konkiep River area Ė EPL 3698) literature review (Vertebrate Fauna & Flora).

Â International Development Consultancy (IDC) PTY LTD on: Rapid Assessment: Biophysical issues (Vertebrate Fauna & Flora) for the Farm Rooisand urban development, Windhoek (Khomas Hochland) Area.

2006

Â International Development Consultants/Aigams Professional Services cc. & Lithon Project Consultants on: Phase 2: IEE (Initial Environmental Examination) for Staff accommodation for a Hospital Facility in Lubango, Angola.

Â AgriBank Namibia Ė Implementation & training towards the Environmental Policy.

Â Enviro Dynamics Ė Trekkopje Uranium prospecting: specialist report (Vertebrate Fauna).

Â Risk-Based Solutions CC Ė Cement factory & quarry: specialist report (Vertebrate Fauna & Flora).

Â International Development Consultancy (IDC) PTY LTD on: Rapid Assessment: Biophysical issues (Vertebrate Fauna & Flora) for the Farm Aris urban development Portion No 8, Windhoek Area.

Â International Development Consultancy (IDC) PTY LTD on: Rapid Assessment:
Biophysical issues (Vertebrate Fauna & Flora) for the Farm Finkenstein urban development, Windhoek Area.
Á Risk-Based Solutions CC Î Coal Deposits in southeastern Namibia (Aranos area) literature review (Vertebrate Fauna & Flora).

2005
Á International Development Consultants/Aigams Professional Services cc. & Lithon Project Consultants on: Phase 1: IEE (Initial Environmental Examination) for a Hospital Facility in Lubango, Angola.
Á SGS regarding a Forest Management Certification Audit Î Savannah Charcoal, Outjo, Namibia.
Á AgriBank Namibia Î Environmental Policy Ï 2005/6.
Á SGS regarding a Forest Management Certification Audit Î Cheetah Conservation Fund, Otjiwarongo, Namibia.

2004
Á Namibian National Commission for UNESCO on: proclaiming Twyelfontein a World Heritage Site (Namibia) Î Reptiles & mammals (Technical Committee).
Á International Development Consultants/Aigams Professional Services cc. on: the Potential Environmental Impacts of establishing a Pharmaceutical Factory at Okahandja.
Á International Development Consultants/Aigams Professional Services cc. & Entheos Aquaculture Enterprises (Pty) Ltd on: the Potential Environmental Impacts of establishing a Fish Farm in the Olushandja Dam area in Namibia.
Á International Development Consultants/Aigams Professional Services cc. on: Assessment & Development of Northern Communal Areas in Namibia - environmental impacts of establishing Small-scale Commercial Farms in communal areas.

2003
Á WildHorus Ltd. on Miombo Production Management Î Aging & Growth Rates of Miombo Î in Tanzania, Kilombero Valley area, Ifakara.

2002
Á Waldeck Farm (Udo Stritter). Determining Carrying Capacity for game and veld condition assessment.
Á Anchor Environmental Consultants CC at NAMDEB on: the influence of the Wet Overburden Mining System (WOMS) on Reptile & Small Mammal diversity.

1990s
Á International Development Consultants/Aigams Professional Services cc. on Bush Thickening and the potential of utilising this wood for charcoal production in Namibia - 1996.
Á Erongo Mining & Exploration Company Ltd - Navachab Gold Mine (Karabib) on the Rehabilitation of the slimes and mine dumps - 1997.
Á International Development Consultants/Aigams Professional Services cc. on the impact of Bush Control Measures on the ecological environment (biodiversity, habitat diversity and landscape considerations) in Namibia - 1997.
EXPERIENCE: OTHER ACTIVITIES

GUEST LECTURE
Â Contract Lecturer in Desert Ecology at the University of Namibia (Zoology II) - 1997.
Â Facilitator in environmental education workshop (!Nara workshop) for NGO trainees during 1997.

PUBLIC PRESENTATIONS

TALKS IN GUEST SPEAKER FOR:
Â Nature Conservation students at the University of Stellenbosch - Fauna of Arabia, 1999.
Â St Paul's College - Tortoises & Research possibilities, July 2007.
Â St Paul's College - Tortoises of Namibia, January 2010.
Â SABS - Protected Tree Species in Namibia, July 2012.

MEDIA

TELEVISION
Â NBC - Presentation on tortoise research in Namibia for the Namibian Broadcasting Corporation - April 2005.
Â BBC - Presentation on the endemic Nama Padloper tortoise for the British Broadcasting Corporation in "Wild in Africa" series - 2006.
Â SABC - Interview on Nature Programme "50/50" (South African Broadcasting Corporation) regarding seal culling in Namibia - October 2006.
Â NBC - Interview on Good Morning Namibia regarding NEWS & Gecko Vision Industrial Park - September 2011.
Â NBC - Interview on Good Morning Namibia regarding NEWS & rhino poaching + SRT activities - July 2012.
Â NBC - Interview on Open File regarding snakes and perceived problems with snakes around Rehoboth - February 2013.

RADIO
Â NBC - Presented a range of talks on wildlife issues (e.g. baboons as problem animals, Namibian ungulates, etc.) in Namibia for the Namibian Broadcasting Corporation - 1997.
Â Radio Kudu - Interview on baboons as peri-urban problem animals - April 2013.
Â Hit Radio Namibia - Statement regarding poaching in Etosha National Park - June 2013.
Â Radio Kosmos - Statement regarding the culling of springbok in National Parks (August 2013); poisoning of elephants in Hwange National Park, Zimbabwe (September 2013); illegal logging issues (October 2013); ivory poaching issues (December 2013); whaling issues (January 2014); mining in protected areas (February 2014); world conservation (March 2014); hunting issues/ivory trade/protected species (April 2014); greenhouse emissions/rhino
poaching (June 2014); energy issues (July 2014); Baines Hydropower issues (August 2014); poaching in Africa (September 2014); Benguela ecology (October 2014); climate change (November 2014); rhino issues (December 2014); baboon problems (January 2015); cheetah issues (February 2015); deforestation (March 2015); poaching in Etosha (May 2015); wild dog issues (August 2015); fire ecology (October 2015); baboon problems (Feb 2016); suricate trade & rhino poaching (April 2016); cetacean capture in Walvis Bay & ivory trade (Sep 2016); global warming (November 2016); kudu/rabies (May 2017); gorilla issues (July 2017); sungazer lizard (August 2017); rhino poaching (October 2017); general poaching issues (November 2017); blue crane decline (December 2017); climate change, poaching, biodiversity issues (October 2018); species extinctions & wildlife trade (May 2019); sustainable utilisation issues (June 2019); captive elephants (August 2019); climate change (September 2019); greenhouse gas, elephant conflict, arctic ice, oil (November 2019); elephant problems (December 2019); ducks as bio-control (February 2020); wildlife markets (March 2020); COVID 19 + wildlife & bees (May 2020); dehorning rhino (June 2020); bees (July 2020); rhino poaching (August 2020); climate change, leopard attack, black rhinos (September 2020); economy & environment; plant extinction; fires; leopards (October 2020); USA elections & environment; farming with rhino horn (November 2020); MSC/FSC; live elephant sales; canned lion hunting (December 2020); wildlife & Covid; flamingos (January 2021); wetlands, climate change, beetles, Darwin (February 2021); greenhouse gasses (March 2021).

SCIENTIFIC PUBLICATIONS

SCIENTIFIC PAPERS

PEER REVIEWED (PAPERS, SHORT COMMUNICATIONS & NOTES)

2020

2019


2018


2017

2016

2014

2013


2012


2011


2010


2009


2008


2007


2006


2005


2004


2001


2000


**NOT PEER REVIEWED (PAPERS & SHORT COMMUNICATIONS)**


1. **Cunningham, P.L.** 1998. Potential Wood Biomass Suitable for Charcoal Production in

**Publications in Progress**

**In Prep:**
1. The variability of bush densities for a few tree species causing bush thickening in central and north-central Namibia.
2. Seasonal variation in springbok *Antidorcas marsupialis* diet in southern Namibia.
4. Pied crow (*Corvus albus*) preys on adult Namaqua sandgrouse (*Pterocles namaqua*). *Lanioturdus*.

**Books/Chapters/Booklets**


**Reports**

[All reports related to the various EIAs conducted are excluded here]


5. Cunningham, P.L. 1997. Ecological Consequences of Bush Thickening with Special Reference to Namibia. Internal report, Polytechnic of Namibia, Department of Natural


PROCEEDINGS


CONFERENCES & WORKSHOPS

AUGUST 2008 Workshop to minimise mass mortalities of reintroduced animals in Mahazat as-Sayd Protected Area, 2-7 August, Taif, Saudi Arabia.

JULY 2007 5th Annual Symposium on the Conservation and Biology of Tortoises and Freshwater Turtles, 24-28 July, Atlanta, Georgia, USA. PAPER PRESENTED: Distribution, status and threats to the tortoises of Namibia.


DECEMBER 2001  4th World Conference in Herpetology, 2-9 December, Colombo, SRI LANKA


APRIL 2000  2nd Arab International Conference and Exhibition on Environmental Biotechnology (Coastal Habitats) Abu Dhabi, UNITED ARAB EMIRATES.

JANUARY 2000  First International Symposium on Arid Zone Environments: Research and Management Options for Protected Areas. Abu Dhabi, UNITED ARAB EMIRATES.

NOVEMBER 1996  Workshop on Mopane Management in Southern Africa. Ongongo College, NAMIBIA.


POSTERS


MAY 2011  How vulnerable is the Husab Sand Lizard to mining? (Wassenaar, T., Henschel, J., Cunningham, P.L., Herrmann, H-W. & Wilson, T.)

MAY 2009  Seasonal dietary preference of male *Gazella subgutturosa marica* Thomas 1897 along foraging trails from central Saudi Arabia (Cunningham, P.L.)

MAY 2009  Group dynamics of *Gazella subgutturosa marica* from central western Saudi Arabia (Cunningham, P.L.)

MAY 2009  Feeding ecology of *Gazella subgutturosa marica* from central western Saudi Arabia (Cunningham, P.L.)

SEPTEMBER 2007  An invasive alien plant road count as a useful monitoring tool: a proposal and some preliminary results Arid Zone Forum, Sutherland, SOUTH AFRICA (Joubert, D.F., Cunningham, P.L., De Cauwer, V. & Robertson, A.)

MAY 2007  Tortoises of Namibia (Information poster) (Cunningham, P.L.)


POPULAR PUBLICATIONS


PAPERS REVIEWED


3. Vulture News: Beilis, N. & Esterhuizen, J. The potential impact on Cape griffon populations due to the trade in traditional medicine in Maseru, Lesotho.


8. Dinteria: Joubert, D.F. The effects of pebble mulch on Acacia mellifera seedling responses to rain.


12. Mammalia: XIA Canjun, YANG Weikan, David Blank, XU Wenxuan, QIAO Jianfang, LIU Wei. Diurnal time budget of goitred gazelles (Gazella subgutturosa Güldenstaedt, 1780) in Xinjiang, China.


16. Folia Zoologica: Xu, W. et al. Diet of Gazella subgutturosa (Güldenstaedt, 1780) and food overlap with domestic sheep in Xinjiang, China.


18. Acta Theriologica: Blank, D. & Yang, W. Sex ratio in goitered gazelles (Gazella
subgutturosa Guld, 1780).


21. **Zoology in the Middle East**: Mohammed et al. First record of sand cat from Iraq.

22. **Behavioural Processes**: Blank, D. Mother-young recognition in goitered gazelle during hiding period.


25. **Mammalia**: Blanford’s fox *Vulpes cana* (Blanford, 1877) from Iraq.


27. **Canid News**: Eid et al. Additional knowledge regarding Blanford’s fox *Vulpes cana* from Jordan.


31. **Zoology**: Blank, D. Alarm in goitered gazelle during rutting period.

32. **Journal of Arid Environments**: Welch et al. Somewhere to hide: Home range and habitat selection of cheetahs in an arid enclosed system.


Laubsher, N. 2007. VSA-studente leer oor bewaring in Kavango. Republikein 26 June 2007: 5. [Info supplied for article]


EDITORIAL ACTIVITIES

NAMIBIAN ENVIRONMENT & WILDLIFE SOCIETY (NEWS) MAGAZINE [ROAN NEWS] (EDITOR)


NAMIBIAN ENVIRONMENT & WILDLIFE SOCIETY (NEWS) NEWSLETTER (EDITOR)

Issue 1 to 5 2002; Issue 1 to 10 2003; Issues 1 to 12 2004; Issues 1 to 12 2005; Issues 1 & 2 2006; Issue 1 2007

SCIENTIFIC SOCIETY OF NAMIBIA BOTANICAL JOURNAL - DINTERIA (EDITOR)


KING KHALID WILDLIFE RESEARCH CENTRE Ï QUARTERLY REPORT (COMPILE & EDIT)

2008: Issue 1 January to March 2008; Issue 2 April to June 2008; Issue 3 July to September 2008

2009: Issue 1 January to March 2009; Issue 2 April to June 2009; Issue 3 July to September 2009

ORGANISATIONS, GROUPS & MEMBERSHIPS

Namibia Environmental & Wildlife Society (NEWS)

Ã Committee Member (2002-2007; 2010-current), Vice Chairperson (2007) & Chairperson (2010-2014)


ã Member 2002 2007; 2010-current
Raptor Working Group - Namibia
Â Involved with Raptor Road Counts throughout Namibia
Â 2005 ñ 2007; 2010-2014

NANGOF Trust
Â Trustee on NANGOF council
Â November 2010-February 2013

ECO-Awards
Â Assessor ñ lodges
Â Lodges assessed: NamibRand Family Hideout; Kroone Camp (Wilderness Safaris); Namib Desert Lodge (Gondwana Collection); Dûsternbrook Guest Farm; Ngepi Lodge, River Dance Lodge, Fish River Canyon Lodge; The Stiltz; Desert Breeze Lodge; Hakos Guest Farm; Heimat Guest Farm; Alte Kalköfen Guest Farm; Kulala Desert Lodge; Little Kulala; Kulala Adventure Camp; Gondwana Canyon Lodge; Gondwana Canyon Village; Gondwana Roadhouse.
Â 2011-2017

Game Rangers Association ñ Namibian Chapter
Â 2012 - current

Namibian Bird Club
Â 2002 - current

Namibian Botanical Society
Â 2002-2018

Emirates Natural History Group (ENHG)
Â Committee Member ñ Al Ain Branch
Â 1999-2003

Technical Committee: Implementation of the World Heritage Convention in Namibia: Twyfelfontein Dossier
Â Committee Member
Â 2004-2007 (Twyfelfontein Proclaimed Namibiaâs 1st World Heritage Site)

National Inter-sectoral committee on the Okavango River Basin
Â Committee Member
Â 2005-2007

Crane Working Group - Namibia
Â Involved with Blue Crane research in Etosha NP
Â 2005-2007

Advisory Board ñ Fisheries Inspectors & Observers Course (FIOC), Ministry of Fisheries & Marine Resources
Â Advisory Board Committee member
Â 2006-2007

Membership (past & present)
Â Herpetological Association, Africa
Â Environment and Wildlife Society, Namibia
Â Game Rangers Association, Namibia
Â Bird Club, Namibia
Â Botanical Society, Namibia

COMPUTER LITERACY
General Computer Programmes
▪ Microsoft Office, Excel & Publisher
Other Programmes
▪ Statgraphics, Sigma Stat, Systat
▪ Integrated System for Plant Dynamics (ISPD)
▪ Biomass Estimate from Canopy Volume (BECVOL)
▪ Mopane harvesting programme (MOPTHIN)

REFERENCES

Dr. E.R. Robinson (Director, KKWRC)
King Khalid Wildlife Research Centre
Thumamah, P. O. Box 61681, Riyadh 11575
Kingdom of Saudi Arabia
Or
Rangeland Ecologist Ī Conservation Programmes
Zoological Society of London
Regents Park, London NW1 4RY
Tel. + 966 1 4044412
Mobile. + 966 507843943
Email: er4809robinson@yahoo.co.uk; robbie.robinson@zsl.org

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Regents Park, London NW1 4RY
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Fax. + 44 (0)20 75865743
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Wildhorus Limited
The Old Rectory, Maidstone Road, Nettlestead, Maidstone
Kent, ME18 5EZ
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Mobile. +44 7941333806
Email: wildhorus@vanhens.freeserve.co.uk; vanhens@hotmail.com

Dr. W.J. Jankowitz (ex Dean, PON)
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Department of Nature Conservation
Polytechnic of Namibia
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Fax. +264-61-2072196
Email: wjankowitz@polytechnic.edu.na
CURRICULUM VITAE: DR. AM NANKELA

Name of Consultant: DR. ALMA NANKELA
Profession/ Specialisation: Archaeologist & Heritage Specialist
Nationality: Namibian
Years' experience: Over 14 years
Membership in Professional bodies: Associations of Southern African Professional Archaeologists (ASAPA), (Member since 2013; Namibia Scientific Society, member since 2017 and International Council of Monuments and Sites (ICOMOS) since 2012.

Key Qualifications / Experiences

A Quaternary and Prehistorian specialist with over 14 years of experience within Namibian culture sector most of which, gained while working at the National Heritage Council. Through her part-time private consulting company, Welwitschia Archaeological Heritage Solutions CC (WAHS); the company provides full-service contract heritage services to private individuals, consulting companies, businesses organizations and government agencies in conducting heritage impact studies as part of the overall Environmental Impact Assessment in the following sectors: infrastructure development including water, wastewater, power lines, roads, dams development, town planning extensions, mining and telecommunications etc. In addition, the company further offers exclusive desert tour guides, heritage tourism training to tour operators and career guidance.

Below are some heritage impact assessment projects conducted and completed over the course of time:

1. **Proposed powerline and acid plant between Gobabis and Leonard Ville, Omaheke region, Namibia.** July 2020: A desktop archaeological impact assessment component as part of the Environmental Impact Assessment report by Risk-Based Solutions (RBS) CC and Consulting Arm of Foresight Group Namibia (FGN) (PTY) LTD on behalf of the proponents.

2. **Proposed Leonard Ville potential mining site, Omaheke region, Namibia.** July 2020: A desktop archaeological impact assessment component as part of the Environmental Impact Assessment report by Risk-Based Solutions (RBS) CC and Consulting Arm of Foresight Group Namibia (FGN) (PTY) LTD on behalf of the proponents.

3. **Proposed mining operations for MCs Nos. 71675-71684 in Communal land and the Ohungu Conservancy, Erongo region.** September 2020: A desktop archaeological impact assessment component as part of the Environmental Impact Assessment report by Risk-Based Solutions (RBS) CC and Consulting Arm of Foresight Group Namibia (FGN) (PTY) LTD on behalf of the proponent.
4. Updated the 2019 desk report for construction for oil explorations in Kavango East and West to include the new 2D Seismic Survey Lines, January 2021: A desktop archaeological impact assessment component as part of the Environmental Impact Assessment report by Risk-Based Solutions (RBS) CC and Consulting Arm of Foresight Group Namibia (FGN) (PTY) LTD on behalf of the proponents.

5. Proposed mining development of base and rare metals in Farm No: 504 Mesopotamia, Khorixas, Kunene Region. 20th January - 31st March 2020. A desktop archaeological impact assessment component as part of the Environmental Impact Assessment report by Healthy Earthy Environmental Consultant CC on behalf of proponents.


8. The construction of the Omuthiya - Ongwediva road project in Oshikoto and Oshana Regions, Section B also known as the Oshakati Bypass, Namibia Project for the Roads Authority of Namibia. 03rd - 23rd July 2018: A desktop archaeological impact assessment component as part of the Environmental Impact Assessment report by Aurecon Namibia (PTY) LTD on behalf of proponent.

9. Walvis Bay Wastewater Treatment Works (WWTW) (Erongo Region, Namibia) 05/2017 – 08/2017: A desktop archaeological impact assessment component as part of the Environmental Impact Assessment report by Aurecon Namibia (PTY) LTD.

10. Mobile Telecommunications Ltd (MTC) Strategic Environmental Assessment (SEA), Entire Namibia. 05/2017 - 02/2018: A desktop and detailed archaeological impact assessment component for the proposed project to feed into the Strategic Environmental Assessment (SEA) report by GCS Water Environmental Engineering Namibia (GCS Namibia) on behalf of proponent.

Below are some archaeological research conducted and completed over the course of time under the auspices of the National Heritage Council:

2020: Archaeological Monitoring studies at Otjohorongo and Gross-Okandjou Farm, Erongo region, Namibia.

2019: Archaeological research at Klein Spitzkoppe, Erongo region, Namibia.
2019:  Calcium oxalate radiocarbon dating: preliminary tests for dating decorated rock art from open-air caves in Erongo Mountains in Namibia.

2018:  Archaeological monitoring Assessment of heritage resources within the Neckartal Dam area, Karas region, Namibia.

2018:  Condition Assessments of archaeological heritage sites in Namibia: Brandberg, Twyfelfontein, Piet Alberts Rock Engraving and Spitzkoppe Mountains.

2018:  Archaeological heritage research in Klein Spitzkoppe, Erongo region, Namibia.


2017:  Condition Assessments of rock art sites in the Brandberg Mountain and Twyfelfontein World Heritage Site, for the National Heritage Council of Namibia.

2016:  Archaeological research in Omandumba Farms, Erongo Mountains Namibia, for the European Union and the National Heritage Council of Namibia.

2015:  A Condition Assessment of rock art panels at Twyfelfontein World Heritage Site in Namibia, for the National Heritage Council of Namibia.

2013:  Rescue Excavation and relocation of graves in Elizabeth Bay, Luideritz, Namibia for the National Heritage Council of Namibia.


**Education:**

**Degrees Obtained:**  Doctors of Philosophy in Archaeology (Double Title)

**Names of institutions:**  University of Ferrara (UNIFE), Ferrara, Italy

**Museum National d’Histoire Naturelle de Paris, (MNHN), Paris, France**

**Years attended:**  January 2014 - March 2017

**Degrees Awarded:**  2019

**Degree Obtained:**  Masters Degrees in Archaeology (Double Title)

**Names of institutions:**  University of Ferrara (UNIFE), Ferrara, Italy

**Museum National d’Histoire Naturelle de Paris, (MNHN), Paris France**

**Years attended:**  2009 - 2011

**Degrees Obtained:**  2013
Degree Obtained: Bachelor Degree in Education: Geography and History
Names of institution: University of Namibia (UNAM)
Years attended: 2005 – 2008
Degree Obtained: 2009

Publications

Below are some publications:


Historia do Institute Politécnico (CEIPHAR), TOMAR, PORTUGAL.

Employment Records:

2017-Date  Consultant at Welwitschia Archeological Heritage Solutions CC
2011-Date  Rock Art Specialist, Heritage Council
2009-2010  History Teacher, Delta School Windhoek
2007-2008: Projects Coordinator, Museums Associations of Namibia
2003-2004: Polling and Registration Officer in Oshana- Electoral Commission of Namibia

Languages:

<table>
<thead>
<tr>
<th></th>
<th>Speaking</th>
<th>Reading</th>
<th>Writing</th>
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<tbody>
<tr>
<td>English</td>
<td>Excellent</td>
<td>Excellent</td>
<td>Excellent</td>
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<tr>
<td>Oshiwambo</td>
<td>Excellent</td>
<td>Excellent</td>
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</tr>
<tr>
<td>French</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
</tbody>
</table>

I, the undersigned, certify that to the best of my knowledge and belief, these data correctly describe me, my qualifications, and experience.

Signature 2021-03-24

Date
CURRICULUM VITAE & ASHLEY JULIUS

CURRICULUM VITAE

PERSONAL DETAILS

Surname
Julius

First names
Ashley Mario Vernon

Date of Birth
1970/01/17

Place of Birth
Cape Town, South Africa

Health
Excellent

Citizenship
South African

Residence Status
Namibian Domicile

Marital status
Married

EDUCATION BACKGROUND

<table>
<thead>
<tr>
<th>Year</th>
<th>Institution</th>
<th>Qualification</th>
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<tbody>
<tr>
<td>1998</td>
<td>University of Stellenbosch</td>
<td>BSc. Degree (Geology, Geochemistry),</td>
</tr>
<tr>
<td>1997</td>
<td>UNISA</td>
<td>Abstract Algebra (MATHIII)</td>
</tr>
<tr>
<td>1987</td>
<td>Klein Nederburg Senior Secondary, Paarl, Western Cape South Africa</td>
<td>Matriculated</td>
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EMPLOYMENT RECORD

<table>
<thead>
<tr>
<th>Date</th>
<th>Company</th>
<th>Position</th>
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<tbody>
<tr>
<td>2016 - Recent</td>
<td>Pioneer Minerals and Mining Consulting</td>
<td>Exploration Manager</td>
</tr>
<tr>
<td>2012-2016</td>
<td>Pioneer Energy and Minerals Consulting</td>
<td>Consultant</td>
</tr>
<tr>
<td>2009-2011</td>
<td>Geocarta, Namibia</td>
<td>GIS and Database Specialist (Consultant)</td>
</tr>
<tr>
<td>2007-2009</td>
<td>Etruscan Resources Inc.</td>
<td>Database Manager</td>
</tr>
<tr>
<td>2005-2009</td>
<td>Stellenbosch Municipality</td>
<td>GIS/Database Controller</td>
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<tr>
<td>2002-2005</td>
<td>Self Employed</td>
<td>Freelance GIS Consultant</td>
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<tr>
<td>1999-2002</td>
<td>EMCON Consulting Engineers</td>
<td>GIS Technician</td>
</tr>
<tr>
<td>1992-1999</td>
<td>Interconsult Namibia</td>
<td>Geo-technician/Geologist</td>
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## Professional Experience/Key Qualifications

<table>
<thead>
<tr>
<th>Company</th>
<th>Projects</th>
<th>Position</th>
<th>Client</th>
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<tbody>
<tr>
<td></td>
<td>Exploration and Development</td>
<td></td>
<td>Jindal Mining Namibia</td>
<td>2012-Recent</td>
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<tr>
<td></td>
<td>Technical Support and geochemical sampling EPL 4318.</td>
<td></td>
<td>Inborn Investments</td>
<td>2012</td>
</tr>
<tr>
<td></td>
<td>Asset Verification; Data Assessment; Technical support</td>
<td></td>
<td>Manila Investments/Kombat Copper</td>
<td>2012-2013</td>
</tr>
<tr>
<td>Etruscan Resources Inc.</td>
<td>Assist with the day to day running of exploration duties and data management</td>
<td>Database Manager</td>
<td>Millennium Challenge Account</td>
<td>2010-2011</td>
</tr>
<tr>
<td>Urban Dynamics</td>
<td>Feasibility Study for a railway between Katima Mullilo and Mowe Bay.</td>
<td>Freelance GIS Consultant</td>
<td>Ministry of Environment and Tourism</td>
<td>2005</td>
</tr>
<tr>
<td>Namib Hydro Search</td>
<td>Annual Drought Relief Drilling Programme Omaheke Region</td>
<td>Geo-hydrologist</td>
<td>Ministry of Agriculture Water and Forestry</td>
<td>2004</td>
</tr>
<tr>
<td>Tim Smalley</td>
<td>Platveld Aquifer Resource Study</td>
<td>Freelance GIS Consultant</td>
<td>Department Water Affairs</td>
<td>2003</td>
</tr>
<tr>
<td>Ministry of Agriculture, Water and Forestry</td>
<td>GIS Systems Design</td>
<td>Freelance GIS Consultant</td>
<td>Department of Agricultural Research and Training</td>
<td>2003</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>---------------------</td>
<td>---------------------------</td>
<td>-----------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>ECON Consulting Engineers</td>
<td>Walvis Bay Spatial Development Initiative (W SDI)</td>
<td>Freelance GIS Consultant</td>
<td>W SDI</td>
<td>2001-2002</td>
</tr>
<tr>
<td></td>
<td>Access-to-Electricity Study Lesotho, funded by the World Bank.</td>
<td>GIS Technician</td>
<td>Lesotho Electricity Corporation</td>
<td>2001</td>
</tr>
<tr>
<td>Inter Consult Namibia</td>
<td>Accra Sustainable Management Programme.</td>
<td>GIS Technician</td>
<td>GILS UK</td>
<td>1999</td>
</tr>
<tr>
<td></td>
<td>Kavango Resource Mapping &amp; Inter consult Namibia.</td>
<td>Geo-Technician/Geologist</td>
<td>Ministry of Environment and Tourism</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Compiled a provisional Groundwater Map and presented to his Excellency Honorable President Sam Nujoma &amp; Inter consult Namibia.</td>
<td>Geo-Technician/Geologist</td>
<td>Ministry of Environment and Tourism</td>
<td>1997-1998</td>
</tr>
<tr>
<td></td>
<td>Northwest Groundwater Investigation, Department Water Affairs; Various Drought Relief Programmes &amp; Kunene; Hardap; Karas; Erongo;</td>
<td>Geo-Technician/Geologist</td>
<td>Department, Geo-hydrology, Ministry of Agriculture, Water and Forestry</td>
<td>1995-1996</td>
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## Professional Affiliation

<table>
<thead>
<tr>
<th>Date</th>
<th>Association/Affiliation</th>
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</thead>
<tbody>
<tr>
<td>1998</td>
<td>Hydro-geological Association of Namibia (HAN)</td>
</tr>
<tr>
<td>Life Long Member</td>
<td>Geological Society of Namibia</td>
</tr>
<tr>
<td>2005-2007</td>
<td>Geographical Information Science of South Africa (GISSA)</td>
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## Languages

<table>
<thead>
<tr>
<th>Language</th>
<th>Skill Level</th>
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<tbody>
<tr>
<td>English</td>
<td>Excellent</td>
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<tr>
<td>Afrikaans</td>
<td>Excellent</td>
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</table>

## Software

| Graphic User Interface (GUI)                                                                 | Databases Management (Access, SQL Server, Postgres SQL, Vertabelo, Navicat, MSSQL Report Services) |
| Network Concepts                                                                                       | Geographical Information Systems (GIS) ARCGIS Desktop GIS/QGIS                              |
| Internet and electronic Mail                                                                                   | Remote Sensing and Image Processing (ER Mapper, Geosoft)                                    |
| Microsoft Office, Open Office (MS Word, Excel, Powerpoint, MS Access, SQL Server Express)                | Programming (ASP.Net, Visual Basic, Java Script, HTML, SQL, Node.js, JQ uery, Django, Python, R-programming) |
| Geological Modeling Software (MicroMine, Surpac, Datamine)                                                  |                                                                                             |
MARVIN NM SANZILA
ENVIROMENTAL CONSULTANT


Ph: +264 81 4788279
Email: marvinconsultants@outlook.com

Qualifications

<table>
<thead>
<tr>
<th>Qualification</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>BSc</td>
<td>2007</td>
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<tr>
<td>Cert</td>
<td>2014</td>
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<tr>
<td>Cert</td>
<td>2015</td>
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</table>

EXPERTISE

- Environmental Assessments and Project Management
- ISO 14001: Environmental Management Systems; EMPs: Implementation and Coordination
- Environmental Auditing
- Stakeholders Consultation
- Film presenter and narrator: [https://vimeo.com/116761669](https://vimeo.com/116761669) and [https://vimeo.com/110487124](https://vimeo.com/110487124)

Marvin Sanzila joined SLR Environmental Consulting (Pty) Ltd in March 2016 as an Environmental Assessments Practitioner and currently serves as a board member of the Environmental Assessment Professionals of Namibia (EAPAN). Prior to this venture, Marvin successfully implemented the Langer Heinrich Uranium's Environmental Management System (ISO 14001) for 5 years, ensuring compliance across the business.

Marvin has assisted various consultants for 5 years in conducting Environmental Impact Assessments (EIAs) for project appraisals with the regulating authorities. All projects experience related to EIAs have been successfully awarded Environmental Clearance Certificates (ECCs) by the regulating authority and are operational, enhancing both local and international business sector while implementing best practice environmental and social management tools.

Apart from Project Management and Environmental Assessments, Marvin has presented and narrated two films, one that emphasizes the role of the environmental Management Act no.7 of 2007 in the modern-day Namibian development context and the other that looks at Namibia's Wetlands and its potential for ecotourism. His diverse capabilities, skills and knowledge and growing passion for environmental management allows an opportunity for a dynamic Environmental Team.

PROJECTS

- Alten Renewable Energy Group (Alten)
  Environmental and Social Management Support for the proposed construction and operation of the 37 MW Solar Power Plant in Mariental, Namibia (2018-2020)
  Role: Environmental and Social Management Support Manager (Construction and Operational Phase).
  Successfully managed the implementation of the Environmental and Social Management System during the construction and operation of a 37 MW Solar Power plant in Mariental. During the construction phase of the project, the Environmental and Social Management Plans (ESMPs) required their implementation in compliance to International Finance Corporation (IFC), Equator Principles (EPS) and the Namibian Regulations.
<table>
<thead>
<tr>
<th>Company</th>
<th>Role</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NAMWATER</strong></td>
<td>Role: Environmental Impact Assessment Practitioner (Project Management Assistant) (Project On-going).</td>
<td>The Feasibility Study is financed through the Government of the Federal Republic of Germany, KfW Development Bank. Namibia Water Corporation Ltd. (NamWater) has been assigned by the Ministry of Agriculture Water and Forestry (MAWF), as the Project Executing Agency, to undertake a feasibility study for the development of a Desalination Plant and Water Carriage System, to secure water supply to the central coastal area of Namibia; Windhoek; as well as en-route users (i.e. towns). SLR (including Marvin) and the Council for Scientific and Industrial Research (CSIR) (South Africa) were jointly appointed by the Project Management Team to undertake the Environmental Screening Study as input into the overall Feasibility Study.</td>
</tr>
<tr>
<td><strong>GALP</strong></td>
<td>Role: Project Assistant: Environmental Practitioner.</td>
<td>EIA process for the proposed offshore Exploration Well drilling in PEL 82 &amp; 83, in the Orange Basin, Namibia. The outcome of the project required the compilation of an EIA Report including the Environmental &amp; Social Management Plan (ESMP). <strong>Environmental Clearance Certificate (ECC) was successfully issued for the project.</strong></td>
</tr>
<tr>
<td><strong>Shell Namibia Upstream B.V.</strong></td>
<td>Role: Project Assistant: Environmental Practitioner.</td>
<td>Project Assistant (Environmental Practitioner) for the Public Consultation Process (including Focus Group Meetings) of the EIA process, correspondence with Client and overall EIA Project Management. Shell Namibia Upstream BV holds PEL 39, which is located adjacent to the southernmost Namibian offshore border with South Africa. Shell is proposed to drill one or possibly two exploration wells in the northern portion of the licence area. <strong>ECC was successfully issued through the regulating authority for the project.</strong></td>
</tr>
<tr>
<td><strong>Swakop Uranium PTY (LTD)</strong></td>
<td>Role: Environmental Impact Assessment Practitioner and Project Manager</td>
<td>Swakop Uranium PTY (LTD) has partnered with CGN Energy International Holdings CO. Limited (CGNEI), a sister Company of Swakop Uranium, to construct and operate a Solar Photovoltaic (PV) Power Plant with a capacity of 12 megawatt (MW) at the Husab Mine to supply power to the processing plant and associated activities. <strong>ECC was successfully issued through the regulating authority for the project.</strong></td>
</tr>
<tr>
<td><strong>European Investment Bank and NamPower:</strong></td>
<td>Role: Project EIA Management Assistant</td>
<td>NamPower has partnered with the European Investment Bank (EIB) proposes to construct and operate a biomass power plant that will generate electricity by the combustion of wood from encroacher bush, growing in the surroundings of the proposed power plant area.</td>
</tr>
<tr>
<td>Role: Environmental Compliance Auditor (Continues to support the Mine through Environmental compliance audits)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td></td>
<td></td>
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<tr>
<td>Environmental Audit for the EMP implementation of the Tschudi Mine in Tsumeb, Namibia.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Role: Environmental Impact Assessment Practitioner</td>
<td></td>
<td></td>
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<tr>
<td>Swakop Uranium PTY (LTD) Scoping report (including impact assessment) for the proposed changes to the Husab mine and linear infrastructure (2018-2019)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swakop Uranium PTY (LTD) Swakop proposed further amendments to the currently approved Husab Mine Plan and associated activities, as follows:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Further alterations of the Waste Rock Dump (WRD) design;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. The Implementation and operation of an on-site incinerator for the purposes of improved waste management;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Six (6) new mobile communication antenna-poles for mobile communication road coverage along the access road to the mine from the B2 turn off.</td>
<td></td>
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<tr>
<td>ECC was successfully issued through the regulating authority for the project.</td>
<td></td>
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<tr>
<td>Role: Environmental Impact Assessment Practitioner</td>
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<tr>
<td>Farm Skakel Environmental Performance Report and Management Plan For Water Abstraction Boreholes (WW10801 &amp; WW10062) On Farm Skakel (2020).</td>
<td></td>
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<tr>
<td>Farm Burnel Environmental Performance Report and Management Plan for Water Abstraction Boreholes (WW 200285 &amp; WW 37681) on Farm Burnel (2020).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm Finsterbergen Environmental Performance Report and Management Plan for Water Abstraction Boreholes on Farm Finsterbergen (2020).</td>
<td></td>
<td></td>
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<tr>
<td>Swakop Uranium Projects and Processing Departments proposed to construct an additional raw water pond for the storage of Raw water supplied by NamWater. The additional pond is not only required to provide the plant with the required volumes of water, but also to ensure suitable volumes of water being stored during scheduled NamWater maintenance shutdown periods.</td>
<td></td>
<td></td>
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<tr>
<td>ECC was successfully issued through the regulating authority for the project.</td>
<td></td>
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</tr>
</tbody>
</table>
**Role:** Environmental Practitioner (Project Manager)

**NamParks is supported by the Federal Republic of Germany through the Kreditanstalt für Wiederaufbau (KfW) Development Bank. The programme (NamParks) has been implemented into development phases (1 to 5). NamParks Phase 4 (NamParks IV) was focused on park management infrastructure development in the Tsau //Khaeb (Sperrgebiet) National Park (TKNP) while Phase 5 is focused on the Skeleton National Coast Park, Namib Naukluft Park and Dorob National Park.**

**ECC was successfully issued through the regulating authority for the NamParks IV.**

**Awaiting ECC for NamParks V.**

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**Earthmaps CC**

- **Scoping Report and EMP for Earthmaps Consulting CC’s Exploration Activities on EPLs 6339 and 6340, North-West of Tsumeb in the Oshikoto Region (2017)**

---

**Votorantim Metals Namibia (PTY) LTD**

- **Scoping Report (including assessment) and EMP for Votorantim Metals Namibia’s Activities on EPL 6521, North-West of Otavi in the Osho"Jinda Region (2017)**

---

**Namibian National Parks Programme Phase II**

- **Scoping Report for Infrastructure Development: Amendment for the proposed Addition of Entrance Gate, Tourist Reception, Staff Housing at Mudumu. (2016)**

---

**ErongoRed**

- **EIA for a new 44 kV powerline between Swakopmund reservoir and the Swakop River Plots (2016).**

---
### Ministry of Agriculture, Water & Forestry (MAWF)

**Role:** Environmental Practitioner (EIA write up, process, review of specialist report and project management)

The Ministry of Agriculture, Water & Forestry (MAWF) through the Division of Agricultural Engineering (DAE) intends to develop an Irrigation Project as part of the Government's Green Scheme in the Zone Area located about 30 km northwest of Nkurenkuru in the Western region of Kavango. An EIA process is required for the project to obtain an ECC.

**ECC was successfully issued through the regulating authority for the project.**

---

### Namibia Construction PTY Ltd.

**Scoping (Including Assessment) Report and EMP for Sand Mining project - 20km South West of Okahandja (2016)**

**Role:** Environmental Practitioner

Namibia Construction (Pty) Ltd is mining sand in the upper reaches of the Swakop River on Farm Osona 65, 20 km south-west of Okahandja town and 6 km East of Gross Barmen. Namibia Construction has been mining sand from this location in the Swakop River between 2011 to 2014 and resumed in 2015 after the river flow reinstated the river sand in the mined-out areas. An EIA process was required as per EIA regulations and EMA.

**ECC was successfully issued through the regulating authority for the project.**

---

### Swakop Uranium PTY LTD

**Scoping Report (including impact assessment) for the proposed amendment to the Husab Mine Linear Infrastructure - 33kV Overhead Powerline at the B2 Vehicle Staging Area (2016)**

**Role:** Environmental Practitioner (for the entire EIA process, including EIA write up, Public Participatory process, review of specialist report and project management.)

Swakop Uranium proposes to erect a 33 kV overhead power line (±1.25 km in length) from the existing Erongo RED 22kV powerline to their B2 Vehicle staging area next to the B2 main road. And EIA process was required for the issue of the ECC.

**ECC was successfully issued through the regulating authority for the project.**

---

### Igneous Mining

**Environmental Certificate Clearance (ECC) Renewal for small scale mining activities on ML 135 in Sarusus Area, Skeleton Coast Park (2016)**

**Role:** Environmental Practitioner for the ECC Renewal Process

Igneous Mining's environmental clearance certificate for ML 135 Small scale mining activities at Sarusus Area in the Skeleton Coast Park is due for renewal. It's with this background that the project still intends to keep the Mining lease until such time that the lease lapses. It has come to terms that Igneous Mining needs to apply for a renewal of their ECC.

**ECC was successfully issued through the regulating authority for the project.**

---

### Swakop Uranium PTY LTD

**Swakop Uranium Internal Environmental Scoping Report for the proposed Sub-Economic Material Stockpiling Area (2016)**

**Role:** Environmental Practitioner for the ECC Renewal Process

Swakop Uranium proposes a minor change and/or addition to the approved Husab Mine design plan and infrastructure specific to stockpiling of Sub Economic Material (SEM) with an average ore grade of 113 ppm. The SEM is proposed to be stockpiled within the perimeters of Pit Zone 1 and Pit Zone 2. An internal screening process was required to assess the impacts associated with the project activity.

**ECC was successfully issued through the regulating authority for the project.**
## Langer-Heinrich Uranium PTY Ltd
**Environmental Compliance Coordinator (2014-2016)**

**Role: Environmental Compliance Coordinator**

The primary purpose of this role is to coordinate the environmental compliance program at Langer Heinrich Uranium (LHU) in order to ensure LHU successfully integrate environmental compliance across the business and retains its licence to operate.

- Coordinate and provide support to ensure impact /aspect and risk assessment registers are up to date
- EMP implementation
- Participate in environmental incident investigations
- Training and awareness
- Conduct assessment of company activities to ensure compliance with ISO /internal standards and facilitate or coordinate environmental audit programme
- Document control
- Environmental register
- Co-ordination, communication & networking

## Langer-Heinrich Uranium PTY Ltd
**Environmental Technician (September 2011-2013)**

**Role: Environmental Technician**

Roles:

- Environmental Aspect and compliance monitoring
- Incident management and data entry
- EMP Compliance
- Site-Contractors compliance to Environmental procedures, Environmental Management Plan,
- Compliance to EMS ISO 14001; Environmental Internal Audits and Reports
- Contribution to Monthly and Bi-Annual Environmental Reports
- Waste management overall mining operation
- Environmental Monitoring
- Maintenance and Utilization of environmental Monitoring equipment
- Training; Environmental awareness, Policy, Spill and Waste management

## MAMOKOBO Video & Research, Ministry of Environment & Tourism.
**Documentary Film; Eco-nomics of Wetlands: supporting livelihoods.** (2011)

**Role: Presenter, Narrator. Filming Logistics and schedule planner**

## Risk Based Solutions cc
**Scoping Report: InnoWind Energy Namibia (PTY) LTD for the proposed 10 MW Solar array Project, Walvis Bay, Erongo Region (March 2011)**

**Role: Environmental Junior consultant**

- Project development stages, Socio- economic (Regional and Local Positive and Negative social impacts, Assessment methodology and procedures.

**ECC was successfully issued through the regulating authority for the project.**
<table>
<thead>
<tr>
<th>Role: Environmental Junior Consultant</th>
<th>ECC was successfully issued through the regulating authority for the project.</th>
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<tbody>
<tr>
<td>Risk Based Solutions cc</td>
<td>Role: Environmental Junior Consultant</td>
</tr>
<tr>
<td>Scoping Report: On Road Investment (PTY) LTD for mining of copper, zinc and gold at farm Elbe 10, EPL 4232 Okahandja, Otjozondjupa Region (November 2010)</td>
<td>Project development stages, Socio-economic (Regional and Local Positive and Negative social impacts, Assessment methodology and procedures, Health and Safety</td>
</tr>
<tr>
<td>Risk Based Solutions cc</td>
<td>Role: Environmental Junior Consultant</td>
</tr>
<tr>
<td>Scoping Report: Zhonghe Resources (Namibia) Development (PTY) LTD for proposed new uranium mine, EPL3602. Arandis area, Erongo region. (October 2010)</td>
<td>Project development stages, Socio-economic (Regional and Local Positive and Negative social impacts, Assessment methodology and procedures.</td>
</tr>
<tr>
<td>Risk Based Solutions cc</td>
<td>Role: Environmental Junior Consultant</td>
</tr>
<tr>
<td>Scoping Report: Logwood Investment (PTY) LTD for mining of Copper and Silver at Klein Aub, EPL 3663, Rehoboth District, Hardap Region (May 2010)</td>
<td>Project development stages, Socio-economic (Regional and Local Positive and Negative social impacts), Assessment methodology and procedures, Health and Safety</td>
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<tr>
<td>Alex Speiser Environmental Consultants CC (ASEC cc)</td>
<td>Environmental Junior Consultant</td>
</tr>
<tr>
<td>Environmental Background and Environmental Management Plan for the development of Eros Load Centre 66/11KV Substation and upgrade of the Olympia Load Centre (March 2010)</td>
<td>Baseline Assessment</td>
</tr>
<tr>
<td>UNDP-MET, Versacon cc</td>
<td>Role: Assistant Coordinator</td>
</tr>
<tr>
<td>Namibia Landscape</td>
<td>Project coordination and management</td>
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<tr>
<td></td>
<td>Pre-Feasibility and Baseline Assessment of the project focal areas and verification of the proposed PLACA demonstration Sites</td>
</tr>
<tr>
<td>Organization</td>
<td>Role and Responsibilities</td>
</tr>
<tr>
<td>--------------</td>
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<tr>
<td>Versatile Environment Consulting cc</td>
<td>Assistant Coordinator</td>
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<tr>
<td>Namibia National Climate Change Policy and accompanying Strategic Action Plan (Mar 2009)</td>
<td>- Administrative support and coordination.</td>
</tr>
<tr>
<td>Versatile Environmental Consulting cc</td>
<td>Environmental Junior Consultant</td>
</tr>
<tr>
<td>(Feb 2009- Feb 2010)</td>
<td>- Project development, management and coordination</td>
</tr>
<tr>
<td>MAMOKOBO Video &amp; Research, Ministry of Environment &amp; Tourism (MET)</td>
<td>Project Coordinator Assistant</td>
</tr>
<tr>
<td>(Feb 2009)</td>
<td>Technical environmental services to Versacon cc:</td>
</tr>
<tr>
<td>Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ)</td>
<td>- Project and programme environmental assessment, EIA.</td>
</tr>
<tr>
<td>Environmental Management Act Film (Feb 2009)</td>
<td>Role: Film Presenter/ Narrator</td>
</tr>
<tr>
<td>MAMOKOBO Video &amp; Research, Ministry of Environment &amp; Tourism (MET)</td>
<td>- Participate in public consultation meetings</td>
</tr>
<tr>
<td>(MET)</td>
<td>- Conduct live interviews with various stakeholders</td>
</tr>
<tr>
<td>Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ)</td>
<td>Environmental Management Act no.7 of 2007, supporting film (A Balancing Act)</td>
</tr>
<tr>
<td>Sept 2008- Dec 2008</td>
<td>Role: Environmental Junior Consultant</td>
</tr>
<tr>
<td>Risk Based Solution cc</td>
<td>- Assessment of Environmental components (Fauna and flora Coastal Settings and the Kunene River Mouth settings, likely impact and management)</td>
</tr>
<tr>
<td>EIA for Northern Namibia Development Company (NNDC) PTY LTD proposed mining and ongoing exploration</td>
<td>- Review of the Legal Framework relevant to the project.</td>
</tr>
<tr>
<td>EPL No. 2633 May - June 2008</td>
<td>Role: Consultant- Enumerator</td>
</tr>
<tr>
<td>SAIEA- Millennium Challenge Account (MCA)</td>
<td>- Baseline data collection and impact assessment of the proposed veterinary cordon fence</td>
</tr>
<tr>
<td>Strategic Environmental Impact Assessment of the construction of a new veterinary cordon fence along Namibia-Angola border (April 2008)</td>
<td></td>
</tr>
<tr>
<td>Role: Consultant- Enumerator</td>
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<td>-----------------------------</td>
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<td>Baseline data collection and impact assessment of the proposed veterinary cordon fence</td>
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<table>
<thead>
<tr>
<th>Role: Assistant Coordinator</th>
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<tbody>
<tr>
<td>Administrative support and coordination.</td>
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<tr>
<th>Role: Environmental Junior Consultant</th>
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<tr>
<td>Review of international, regional and national agreements/policies/legislation relevant to project</td>
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<tr>
<th>Role: Environmental Junior Consultant</th>
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<tbody>
<tr>
<td>Provision of information and data about coastal and marine regarding sensitivity, ecological importance and other relevant attributes of block 1911</td>
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<thead>
<tr>
<th>Role: Environmental Junior Consultant</th>
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</thead>
<tbody>
<tr>
<td>Preparation and provision of information about the Kunene River mouth, key species, sensitivities and threats.</td>
</tr>
</tbody>
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<tr>
<th>Role: Project Assistance</th>
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<table>
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<tr>
<th>Role: Environmental Junior Consultant</th>
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<tbody>
<tr>
<td>Review of policies, legislation and international conventions in the context of the project and biodiversity conservation</td>
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<tr>
<th>Role: Environmental Junior Consultant</th>
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<tr>
<td>Compilation of quantitative data on past, present, future petroleum industry activities and techniques for drilling in a GIS compatible format.</td>
</tr>
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<tr>
<th>Role: Environmental Junior Consultant</th>
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</thead>
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<tr>
<td>Identification and compilation of data on biological, physical and chemical elements most likely to be affected at sites of existing petroleum exploration and production activities.</td>
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<tr>
<th>Role: Environmental Junior Consultant</th>
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<tr>
<td>Analysis of common impacts and project specific impact from oil/gas exploration</td>
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</tbody>
</table>

**SAIEA- Millennium Challenge Account (MCA)**
Strategic Environmental Impact Assessment of the construction of a new veterinary cordon fence along Namibia-Angola border (April 2008)

**Versatile Environment Consulting cc**
Namibia National Climate Change Policy and accompanying Strategic Action Plan (Mar 2009)

**Versatile Environmental Consulting cc**
EIA for a Seismic Survey in Block 1911, offshore Namibia (April 2007)

**SAIEA**
Trans-boundary issues of the Orange-Senqu river basin waters May 2007

**Versatile Environmental Consulting cc**
Data gathering and gap analysis for modeling of the cumulative effects of offshore petroleum exploration and production activities on the marine environment in the BCLME region. (February 2007)
### National Botanical Institute (NBRI), Namibia Biodiversity Database (NaBiD)

**Role:** Data Coordinator

Facilitation of baseline biodiversity data through the Brown Hyena Research Project for conservation planning of the Sperrgebiet National Park (Feb 2006 - Jan 2007)

### Versatile Environmental Consulting cc

**EIA for a Seismic Survey in Block 1911, offshore Namibia (April 2007)**

**Role:** Environmental Junior Consultant

- Review of international, regional and national agreements/policies/legislation relevant to the project
- Provision of information and data about coastal and marine regarding sensitivity, ecological importance and other relevant attributes of block 1911
- Preparation and provision of information about the Kunene River mouth, key species, sensitivities and threats.

### Versatile Environmental Consulting cc

**EIA for proposed development of guano platforms near Sandwich Harbour Walvis Bay (March 2007)**

**Role:** Environmental Junior Consultant

- Review of policies, legislation and international conventions in the context of the project and biodiversity conservation.

### SAIEA

**Trans-boundary issues of the Orange-Senqu river basin waters May 2007**

**Role:** Project Assistance

### Versatile Environmental Consulting cc

**Data gathering and gap analysis for modeling of the cumulative effects of offshore petroleum exploration and production activities on the marine environment in the BCLME region. (February 2007)**

**Role:** Environmental Junior Consultant

- Compilation of quantitative data on past, present, future petroleum industry activities and techniques for drilling in a GIS compatible format.
- Identification and compilation of data on biological, physical and chemical elements most likely to be affected at sites of existing petroleum exploration and production activities.
- Analysis of common impacts and project specific impact from oil/gas exploration.
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<tr>
<th><strong>National Botanical Institute (NBRI), Namibia Biodiversity Database (NaBiD)</strong></th>
<th>Role: Data Coordinator</th>
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<tr>
<td>Facilitation of baseline biodiversity data through the Brown Hyena Research Project for conservation planning of the Sperrgebiet National Park (Feb 2006- Jan 2007).</td>
<td></td>
</tr>
<tr>
<td><strong>Ministry of Fisheries and Marine Resources (Marine Mammal Section)</strong></td>
<td>Role: Assistant Fisheries Technician</td>
</tr>
<tr>
<td>Cape fur seal Project</td>
<td></td>
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<tr>
<td>Jan ¹ Feb 2004</td>
<td></td>
</tr>
<tr>
<td>1 MEMBERSHIPS</td>
<td>Professional Membership</td>
</tr>
<tr>
<td><strong>ENVIRONMENTAL ASSESSMENT PROFESSIONALS OF NAMIBIA (EAPAN)</strong></td>
<td></td>
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¹ This role was held during the period Jan ¹ Feb 2004.