MEL Oil and Gas Exploration (Namibia) (Pty) Ltd

Final Environmental Impact Assessment (EIA) Report for the Proposed 2D Seismic Survey Operations covering the Areas of Interest (AOI) in the Petroleum Exploration License (PEL) No. 93, Owambo (Etosha) Basin, **Oshikoto and Ohangwena Regions, Northern Namibia**

MEL Oil and Gas Exploration (Namibia) (Pty) Ltd
c/o Pioneer Oil and Gas Consulting
City View Building Unit 13
Corner of Pasteur and Freud Street
WINDHOEK, NAMIBIA

APRIL 2022

OPERATOR

Mel Oil and Gas Exploration (Namibia) (Pty) Ltd

MEFT ECC APPLICATION REFERENCE No.

APP-003664

PETROLEUM EXPLORATION LICENSE (PEL)

PEL No. 93 covering Blocks 1718 and 1818

WORKING INTERESTS

MEL Oil and Gas Exploration (Namibia) (Pty) Ltd 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

PROPONENT NAMIBIAN ADDRESS

c/o Pioneer Oil and Gas Consulting
City View Building Unit 13
Corner of Pasteur and Freud Street
WINDHOEK, NAMIBIA

PROPONENT OVERSEAS ADDRESS

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ENVIRONMENTAL ASSESSMENT PRACTITIONER (EAP)

Ms. Emerita Ashipala
MSc Env. Mag, BSc (Hons) Envi Bio

ASS. EAP / PROJECTS DIRECTOR PROJECT / PERMITTING DE-RISKING ADVISOR

Dr Sindila Mwiya
(*PhD, PG Cert, MPhil, BEng (Hons), Pr Eng*)

CITATION: ***Risk-Based Solutions (RBS), 2022***. *Final Environmental Impact Assessment (EIA) Report for the Proposed 2D seismic survey covering the Area of Interest (AOI) in the Petroleum Exploration License (PEL) No. 93, Owambo (Etosha) Sedimentary Basin, Oshikoto and Ohangwena Regions, Northern Namibia.*

ENVIRONMENTAL IMPACT ASSESSMENT (EIA) REPORT CONSULTING TEAM LEADERS

Name of Key Team Leaders	Project Role / Position / Specialisation	Affiliation / Company
Ms Emerita L. Ashipala	EAP/Senior Consultant specialised in Environmental Assessment Impact Assessment and Management /ESG/ Stakeholders and Community Consultations and Engagement	Risk-Based Solutions (RBS) CC
Dr Sindila Mwiya	Assistant EAP / Permitting De-Risking Advisor specialised 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**).	Risk-Based Solutions (RBS) CC
Dr Vita Stankevica	Quality Control Manager and Socioeconomic Project Specialist Consultant	Risk-Based Solutions (RBS) CC
Mr Don Nyambe	Senior Consultant / Quality Control /ESG/ Public, Stakeholders and Community Consultations and Engagement	Risk-Based Solutions (RBS) CC
Dr Onjefu Sylvanus Ameh	Environmental, Aerosol, Noise, Radiation and Occupation and Safety Project Specialist Consultant	Risk-Based Solutions (RBS) CC
Peter Cunningham	Flora, Fauna, and Habitats Project Specialist Consultant	Environment and Wildlife Consulting Namibia
Dr Alma Nankela	Archaeologist- Quaternary and Prehistorian Project Specialist Consultant	RCHS - Archaeosciences and Consultants
Mr. Ashley Julius	Water (Geology, Hydrology, Groundwater, and Water Supply) Project Specialist Consultant	Pioneer Minerals and Mining Consulting
Ms. Meriam Kauyama	Project administration, public, stakeholders and Community Consultations and Engagement Consultants	Risk-Based Solutions (RBS) CC
Ms. Christine K. Links		

Ms EMERITA L. ASHIPALA, ENVIRONMENTAL ASSESSMENT PRACTITIONER (EAP)
DECLARATION

I, Emerita ASHIPALA, the Environmental Assessment Practitioner (EAP) for this Environmental Assessment process for the proposed 2D seismic survey covering the Areas of Interest (AOI) in the Petroleum Exploration License (PEL) No. 93, Oshikoto and Ohangwena Regions, Northern Namibia for MEL Oil and Gas Exploration (Namibia) (Pty) Ltd (Proponent), hereby declares that:

1. This Environmental Impact Assessment (EIA) Report has been prepared in accordance with the provisions of the Environmental Protection Clause 11 of the Model 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), all other applicable national laws and Regulations.

2. As the EAP for this Project, I am qualified and experienced oil and gas exploration and hold a MSc Environmental Management (Oil and Gas pathway) and Hons. Degree in Environmental Biology. I have undertaken environmental impact assessments and management plans for various resources companies, Maps compilation for various projects using Google Earth and ArcGIS, Data entry, data organisation with quality control, Liaise and communicate with clients and relevant stakeholders, enforce Environmental compliance, Health, Safety, Security, and Environment as required by certain policies and standards.

3. I have been an Environmental Assessment Practitioner (EAP) for various projects and I have extensive technical knowledge and experience in conducting environmental assessments, management, and monitoring, and have in the past undertaken projects in oil and gas exploration related environmental assessments, management, and monitoring projects.

4. I have performed the work relating to this project in an objective manner, even if the outcomes will result in views or Records of Decision that may not be favourable to the Stakeholders or the Proponent, and.

5. I am an independent consultant not related to the Proponent and work as an independent senior consultant associated with Risk-Based Solutions CC not related to the Proponent. Except for the fees payable for professional consulting services rendered to the Proponent through Risk-Based Solutions CC, 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.

……

Ms Emerita L. Ashipala
Environmental Assessment Practitioner (EAP)
RISK-BASED SOLUTIONS (RBS) CC

DR SINDILA MWIYA, ASSISTANT ENVIRONMENTAL ASSESSMENT PRACTITIONER (EAP)/ PERMITTING DE-RISKING ADVISOR DECLARATION

I, Dr Sindila Mwiya, the Project Permitting De-Risking Advisor and Assistant EAP for this Environmental Assessment process for the proposed 2D seismic survey covering the Areas of Interest (AOI) in the Petroleum Exploration License (PEL) No. 93, Oshikoto and Ohangwena Regions, Northern Namibia for MEL Oil and Gas Exploration (Namibia) (Pty) Ltd (Proponent), hereby declares that:

1. This Environmental Impact Assessment (EIA) Report has been prepared in accordance with the provisions of the Environmental Protection Clause 11 of the Model 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), all other applicable national laws and Regulations.

2. As the Project Permitting and De-Risking Advisor and Assistant EAP for this Project, I am highly qualified and experienced in onshore oil and gas exploration and production operations and hold a PhD with research interests, academic training, and technical knowledge in Engineering Geology, Geotechnical, Geoenvironmental and Environmental Engineering, Artificial Intelligence and Knowledge-Based Systems with special focus on EIAs, EMPs, EMSs, SEAs, SEMPs and ESG with respect to subsurface resources (minerals, petroleum, water) and energy in Arid and Semiarid Environments.

3. I am an **Engineering and Environmental Geologist** and I have extensive technical 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 project in an objective manner, even if the outcomes will result in views or Records of Decision that may not be favourable to the Stakeholders or the Proponent, and.

5. I am an independent consultant not related to the Proponent, I own and operate an independent company (Risk-Based Solutions CC) which is not related to the Proponent. Except for the fees payable for professional consulting services rendered to the Proponent, 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
Assistant EAP / Permitting De-Risking Advisor
RISK-BASED SOLUTIONS (RBS) CC

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Non-Technical Summary

MEL Oil and Gas Exploration (Namibia) (Pty) Ltd herein referred as "**MEL**" holds petroleum exploration rights under the Petroleum Exploration License (PEL) No. 93 covering Degree Square Blocks 1717 and 1817, in the Owambo Sedimentary Basin, Oshikoto and Ohangwena Regions, in the Northern Namibia. MEL Oil and Gas Exploration (Namibia) (Proprietary) Limited, is a subsidiary of Monitor Exploration Limited. MEL is the Operator of PEL 93 holding 75% of the license interests, National Petroleum Corporation of Namibia (Namcor), a Namibian State-owned company (Parastatal) holds the 10% interest in the Licence with its costs carried to the development stage, and 15% is held by local partners.

As part of the provisions of the Petroleum Agreement signed between MEL 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 93. The Petroleum Agreement provides for the first renewal exploration period of two (2) years is subject to one (1) well with U$ 10 million commitment carrying local partners expected to commence in October 2022. The second renewal exploration period of two (2) years with 2D seismic or 1 well (U$ 10 million). This year the company is committed to conduct an EIA and seismic, covering 200-400 km 2D seismic acquisition and commence drilling of 2-3 wells. The target raise is to approximately U$ 20-30 million through: Private Placement, or merger with suitable partner, or Farm-in by a qualified operator.

The Proponent intends to conduct approximately 576 km long 2D seismic survey operations as part of its exploration commitments with the Namibian Government. Except for 105 km lines comprising lines 5, 8, 12 and 15 that will require new cutlines subject to the approval or request of the land owners, the rest of the other proposed survey lines will be conducted along existing roads, tracks, and farm boundary fences. The request or approval by the land owners to create new cutlines for the proposed survey may be based on the need to support the existing land management strategies such as a firebreak for wildfire management or new access connecting areas that were inaccessible.

The Proponent intends to use either the Explorer 860 Accelerated Weight Drop (AWD) or vibroseis trucks such as the Nomad 65 Vibrator as the energy source with wireless receivers to allow for greater lines offset. The rear mounted weight-drop from the Explorer 860 or the centred vibrating metal plate from a Nomad 65 will each generates acoustic / sound waves that will penetrate deep into the ground below each of the proposed survey lines and will bounced off the various subsurface rock layers. Receivers installed along the survey lines at between 5 – 10 m station intervals will measure the returning sound / acoustic waves. The resultant product following complex computer-based processing, is a vertical sonic cross-section of the subsurface beneath each of the surveyed lines showing the geological materials (de-risked geological sub-model). The interpreted 2D seismic survey data sets is used to find specific drilling locations where potential reservoirs within the AOI where oil or gas may have accumulated and trapped in sufficient commercial quantities. The following is summary of the key Areas of Interest (AOI) within PEL 93:

(i) AOI-01 Northeast of Oshivelo, covers 151 km of seismic over a large structure identified from gravity data. The objective is to acquire seismic data to define the structure within AOI01, specifically where Geochem shows encouraging anomalies.

(ii) AOI-02 North of Oshivelo cover about 108 km, this will be defined and mapped out the closure of one of the structures within AOI02. The new seismic together with the existing seismic should be able to generate a prospect with positive Geochemical and Passive Seismic Surveys (PSS), and.

(iii) AOI-00 large anticlinal structures south of Oshivelo, covers 317km. The objective is to acquire seismic data to be able to generate a potential drillable target on AOI00, specifically where Geochemical and Passive Seismic Surveys have shown encouraging results.

The interpreted 2D seismic survey data sets will be used to locate specific drilling locations where potential reservoirs within the AOI where oil or gas may be trapped in sufficient commercial quantities. Oil and gas exploration involves the implementation of multiple but interlinked exploration steps over many years and each major step such as seismic survey, drilling or production requires a separate environmental assessment process 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 implementation of the environmental assessment process must be undertaken in accordance with the provisions of the Environmental Management Act, 2007, (Act No. 7 of 2007) and EIA Regulations, 2012.

In fulfilment of the environmental requirements, MEL (Pty) Ltd appointed Risk-Based Solutions (RBS) CC as the Environmental Consultant and led by Dr Sindila Mwiya as the Permits De-risking Advisor and Ms. Emerita Ashipala as the Environmental Assessment Practitioner (EAP) to undertake the environmental assessment covering Environmental Impact Assessment (EIA) and preparation of the Environmental Management Plan (EMP) to support the application for Environmental Clearance Certificate (ECC). All Interested and Affected Parties (I&APs) were invited to register and submit written comments / objections / inputs with respect to the proposed 2D seismic survey operations covering the key Areas of Interests (AOI) in PEL 93. A Draft Scoping Report was provided to all registered stakeholders. Local community consultation meetings were organised through the Oshikoto Regional Council in collaboration with the local Councillors and traditional authorities during the months February and March 2022. Registered letters with the Draft Scoping Report were also send to the various land owners in the area likely to be surveyed. Additionally, all the environmental reports submitted to the Environmental Commissioner will be subjected to further public consultation and disclosure requirements 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 expected to be end of March 2022.

The Environmental Assessment process undertaken for the proposed 2D seismic survey operations as detailed in this EIA report, focused on the assessment of the various components of the receiving environment with respect to the equipment to be used and local community inputs from consultations and engagements undertaken. The assessment process has taken took into consideration, all the applicable national regulations, the corporate requirements of the Proponent, oil and gas exploration and environmental assessment international best practices, 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, field scouting and mapping of buffers and offsets along proposed survey lines).

(ii) Base camp and fly-camps site setups and operations.

(iii) Widening of tracks by pruning vegetation overgrowth and tracks levelling as may be applicable.

(iv) Creation of new access especially in areas where there is no existing access.

(v) Actual survey operation (data acquisition).

(vi) Demobilisation and closure (Survey Completion), and.

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

The proposed 2D seismic survey operations covering the key exploration Areas of Interest (AOI) within falls within the hot semi-arid climatic zone of northern Namibia, with very hot to 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 bordered by the Otavi Mountainland Land in south. Rainfall falls mostly in summer with no rainfall of significance between May to August. The exploration area receives rainfall between December to March, with the highest rainfall peaking in January. The annual average rainfall around the proposed survey area is between 500-600 mm.

Within the key areas of interest, the following tribal (traditional) authorities fall within the Oshikoto Region: Guinas, Nehale LyaMpingana, and Eengondi tribal authorities. The land use in the general area is mainly large to small-scale communal / subsistence farming comprising cattle, goats, seasonal crop farming, particularly to the north of the region. To the south of the proposed survey area much of the land is used for agriculture, conservation, and tourism freehold land, with resettlements, and government or parastatal. Freehold (commercial) conservation and tourism related land uses such as the Onguma Game Reserve are common around the commercial farms found to the southwest and southern parts of the proposed survey area. Commercial cattle and small stock agriculture with irrigated crop farming operations are among the key activities undertaken in both freehold and communal commercial farmlands. Bush thickening or encroachment is viewed as an economic problem in the general area. No communal conservancies occur within the proposed survey area with the closest being the King Nehale Conservancy located to the northwest bordering the Etosha National Park with the major wildlife resource listed as gemsbok, springbok, kudu, blue wildebeest and giraffe (NACSO 2009, 2011). The closest Government protected area is the Etosha National Park. The Onguma Game Reserve is the closest freehold (commercial) conservation area consisting of farms bordering the Etosha National Park southwest of Oshivelo.

It is estimated that at least 67 species of reptile, 15 amphibian, 86 mammal, 213 bird species (breeding residents), 131 larger trees and shrubs (>1m in height) and 111 grasses are known to or expected to occur in the general area of which a low proportion are endemics (e.g., 14.9% for reptiles being the highest).

There are two major drainage systems in the Region namely Cuvelai at the north west stretched from Angola to Etosha pan and the Omuramba which is stretched from Otavi highlands and drainage to Etosha pan. The area of interest within the Owambo (Etosha) Sedimentary Basin falls within the greater Kalahari Basin which was formed because of uplift of the Great Escarpment of Namibia and deposition of Kalahari Group Sediments in grabens which formed during various tectonic events that shaped the current landscapes of Southern Africa and Namibia. The source rocks with favourable generation potential are associated with the Otavi Group carbonates which are also potential reservoirs in addition to the local sandstones anticipated to occur within the AOI.

Groundwater is the main key sources of water supply within AOI falling within the Cuvelai-Etosha groundwater Basin which is the Namibian part of the Cuvelai River catchment. All drainage is thus in the direction of the Etosha Pan. The proposed 2D seismic survey operations cover the Etosha Limestone Aquifer (KEL), the Oshivelo Multi-layered Aquifer (KOV) and the Ohangwena Multi-layered Aquifer (KOH). Local calcrete and sand formations of the Kalahari as well as sandstones and carbonates are main key aquifers in the general local area. Groundwater levels vary from 6-80 m in unconfined shallow aquifers of the Andoni Formation, few metres to 25 m below ground level within the Etosha Limestones and 70 to 90 m along the Tsintsabis-Oshivelo road westward. Groundwater recharge is through the annual flows within the topographic low-lying areas as well as from the northern margins of the carbonates of the Otavi Mountainland.

Overall, the proposed 2D seismic survey activities will have high short-term 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, short-term duration, localised extent, and low probability of occurrence due to the limited scope of the proposed activities to be conducted along existing roads, tracks, and farm boundary fences. The survey will utilise wireless receivers which will make it easier to deploy larger, denser and achieve wider 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 within lower and higher bands.

The rear mounted weight-drop from the Explorer 860 will each generate acoustics or sound waves with frequency of between 150 to 300 Hz depending on peak force used. The Vibroseis such as the Nomad 65 has a range of frequencies from 1-250 Hz to choose from depending on the sensitivity of the receiving environment. The use of either the Explorer 860 or Vibroseis as the source of energy is unlikely to affect the local fauna. The operational frequencies can be pre-set to avoid any interferences

with the receiving local environment such as the elephants known to have communication frequency ranges of between 15-35Hz, far below the survey frequencies. Hence, an insignificant interference.

Interference is defined as the effect produced when two waves of the same frequency, amplitude and wavelengths travelling in the same direction in a medium are superposed (i.e as they simultaneously pass-through a given point). When the crests of two waves of equal wavelength are together, the waves are said to be in phase, that is, they have a phase difference of zero. In this case, according to the principle of linear superposition, the waves will reinforce each other, or add up and will undergo constructive interference and thus affect elephant vocalisation. On the other hand, if two waves superimpose with each other in opposite phase, the amplitude of the resultant is equal to the difference in amplitude of individual waves, resulting in the minimum intensity of the wave. This is known as destructive interference and thus will produce a negligible effect on elephant vocalisations. 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 or construction site soil compactions or rock breaking processes would cause more vibration to a house than a typical seismic truck operating in the area. Studies have shown that noise and vibration may interfere with elephant's vocalisation only when the noise and vibration have the same frequencies as that of the elephant.

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 in 2007 and south of Nkurenkuru in Kavango West Region in 2017 as well as the October 2021 completed 2D seismic survey in PEL 93 supported by wildlife monitoring before, during and after the survey, no significant negative environmental impacts have been observed and reported on all the various sensitive components of the receiving environment. Onshore seismic is a nonintrusive high-tech survey method that can be used 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 and especially the old and poorly engineered infrastructures.

It is very important to note that the waves generated by a 2D seismic survey are different from the earthquake created seismic waves. Earthquake generated seismic waves have periods, and wavelength that are in minutes and kilometres, respectively, while the 2D seismic survey operations produces waves with periods, and wavelength of tenths of a second and tens of a meter respectively. Therefore, the level of ground displacement associated with the type of waves generated by an onshore seismic survey operation compared to an earthquake event, differs considerably. Earthquake ground displacement are in meters and can result in weak buildings collapsing while the millimetre / few centimetres onshore seismic survey operations ground displacement will generally have negligible to minor effects on infrastructures.

Mitigation measures have been recommended and are contained in a separate EMP Report. Through the effective implementation of the mitigation measures and performance monitoring by the Proponent, the overall likely negative impacts of the proposed 2D seismic ground seismic survey activities on the receiving environment (physical, socioeconomic, and biological) will be low and localised with medium to low significant negative impacts. The process of cutting the new proposed cutlines to be used for seismic data acquisition within the private and communal farmlands where no access exists will have localised medium significant negative impacts on the forest habitat without mitigation. Direct supervision, involvement, and continuous monitoring of the process of creating new cutlines by private and communal land owners, will reduce any likely medium significant negative impacts to low. 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 seismic survey over the key Areas of Interest (AOI) in PEL No. 93 shall be granted with an Environmental Clearance Certificate (ECC) with the following key conditions:

1) The proposed 2D seismic survey shall be undertaken in line with the provisions of the EMP, conditions of the Environmental Clearance Certificate (ECC) to be granted by the Environmental Commissioner, national and international environmental best practices, standards, and guidelines.

2) The Proponent shall adhere to the provisions of all the national legislation, regulations, policies, procedures, permits / authorisation requirements provisions of the EMP and mitigation measures shall be implemented, monitored and reported to the regulators as may be applicable or required by law.

3) Before the implementation of the proposed 2D seismic survey operations, the Proponent shall consult with the local community / owners of the private and communal land and villages that may be affected or likely to be disturbed by the proposed project activities. All the consultations and engagements shall be undertaken through the existing regional and local structures starting with the Office of the Governors for Oshikoto Region within which all the AOI falls, Councillors, Traditional Authorities, Village Headpersons, and Village Development Committees (VDCs), local community levels and private commercial farm owners.

4) Before any form of field-based activities are started in a local area, written consent shall always be obtained from the land owners. For communal land areas consent shall be obtained through the village headperson, traditional authorities, and regional council as may be applicable to avoid misunderstanding and unnecessary conflicts.

5) Appropriate setback distances (exclusion zones) around sensitive structures such as villages, boreholes, water wells, dams, pipelines, burial grounds, cultural sites, irrigation canals and monuments / archaeological resources sites shall always be observed as provided for by the International Association of Geophysical Contractors (IAGC) the Distance Requirements Exploration Directive 2006-15, Alberta Government, Canada guidelines.

6) During the 2D seismic survey operations, MEL shall employ Local Community Liaison Officers (LCLO) from the local area to coordinate communications, consultations and engagement activities.

7) A field-based wildlife expert shall also be employed to monitor wildlife activities with respect to the survey activities along the seismic survey lines before, during and after the survey operations and work with other local researchers and MEFT personnel in area working on wildlife related monitoring activities, and.

8) Precautionary principles / approaches shall always be exercised especially in situations where specific mitigations, regulatory guidelines, standards, or appropriate setback distances (exclusion zones) around sensitive local cultural resources such as burial or cultural sites have not been provided. Local communities shall always be consulted on matters related to sensitive local cultural resources not provided for in the national or international guidelines / standards.

1. PROJECT BACKGROUND

1.1 Introduction

MEL Oil and Gas Exploration (Namibia) (Pty) Ltd herein referred as "MEL" holds petroleum exploration rights under the Petroleum Exploration License (PEL) No. 93 covering Degree Square Blocks 1717 and 1817, in the Owambo (Etosha) Sedimentary Basin, Oshikoto and Ohangwena Regions, in the Northern Namibia (Figs. 1.1 and 1.2). PEL 93 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. MEL Oil and Gas Exploration (Namibia) (Proprietary) Limited, is a subsidiary of Monitor Exploration Limited. MEL is the Operator of PEL 93 holding 75% of the license interests whereas the National Petroleum Corporation of Namibia (Namcor), a Namibian State-owned company (Parastatal) holds the 10% interest in the Licence with its costs carried to the development stage, and 15% is held by local partners.

1.2 PEL Legal Obligations and Exploration Model

The exploration activities that MEL has undertaken, is currently undertaking, and is planning to undertake form part of the work commitments and legal obligations as agreed between MEL 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).

Petroleum exploration involves the implementation of multiple exploration steps over many years and each of the following summarised general steps 1-5 below 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 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 the various types of production method that may be used produce the oil or gas. At present Namibia has no commercial or economic 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.

Within the process of defining and validating of a theoretical petroleum exploration model, various input variables and possible outcome scenarios are assessed throughout the exploration journey. On the onset, the entire Owambo Basin encompasses approximately 268,000-350,000 square kilometres and represents an underexplored basin when comparing the size and exploration efforts undertaken in the Basin to date (Fig. 1.3). Namibia shares the Owambo Basin with Angola, whose southern border roughly divides the basin in half. The basin has little surface expression, less than 100 meters relief, with its lowest point lying on the Etosha Pan at 1084 meters above sea level.

The following is the summary of the existing geological and geophysical data sets that has been used to develop the exploration / hydrocarbon model for PEL 93 to be validated by the proposed 2D seismic survey operations followed by drilling operations on site-specific locations that may be delineated by the 2D seismic survey data interpretation:

- High Resolution Airborne Magnetic Data: Extracted features could be associated to magmatic intrusions that might have influence on the petroleum system of the area.

- Radiometric Data interpretation: Drad anomaly derived from the use of mathematical method named Drad.

- Gravity Data interpretation: Two main gravity anomalies detected; several positive gravity anomalies (gravity highs) match well with structural traps mapped from old 2D seismic data.

- Soil Gas Sampling: Geochemical data confirms active petroleum system; higher concentration in surroundings of the potential anticlinal structures.

- 2D Seismic data: 473 km of conventional 2D seismic data, 6 seismic profiles within the blocks; new interpretation reveals potential targets for exploration; identified ramp anticlines, stratigraphic traps and antiformal traps associated to tectonic inversion and fore-bulge deformation structures.

- Remote Sensing: a.k.a. Satellite Imaging as DHI carried out recently over 1717 and 1817, and.

- Passive seismic spectroscopy over 3 leads based on previous data: AOI 00, 01 and 02; results consistent with available data.

The following is the summary of the data integration approach that has been adopted in the development of the key prospects or Areas of Interest (AOI) 00, 01 and 02 within PEL 93 (Figs. 1.2 and 1.3):

- AOI 00 (385 km² surveyed of which 144 km^2 identified as prominent anomaly): An anticlinal structure (gravity data); higher Ethane gas with concentration at the surface; remote sensing shows hydrocarbon seepages; very good correlation with passive seismic anomalies, especially located on top of the anticlinal structure that could be a feasible hydrocarbon trap. Further to the east, remote sensing suggests more exploration opportunities.

- AOI 01 (381 km² surveyed): Located over gravity high, associated with a large anticlinal structure; passive seismic results not as consistent with all existing data; some overlap with Ethane gas readings in the southeast, and.

- AOI 02 (371 km² surveyed of which 58 km^2 identified as prominent anomaly): Area with most existing data; two gravity anomalies present; intercepted by 2D seismic lines; seismic line OSH4 shows 3 levels of structures; significant coincidence with passive seismic anomalies and high readings of Ethane gas on top of structural highs.

1.3 PEL and Relevant Environmental Assessment Process

1.3.1 Overview of MEL Exploration Activities

The company is currently in their initial exploration phase with all commitments met up until this stage. The first renewal exploration period of two (2) years is subject to one (1) well with U$10 million commitment carrying local partners expected to commence in October 2022. The second renewal exploration period of two (2) years with 2D seismic or 1 well (U$ 10million).

This year the company is committed to conduct an EIA and seismic, covering 200-400 km 2D seismic acquisition and commence drilling of 2-3 wells. The target raise is to approximately U$20-30 million through: Private Placement, or merger with suitable partner, or Farm-in by a qualified operator. Subsequent to the grant in October 2018, MEL 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. Passive seismic has been completed over the AOI, the main objective was to identify the zones with the highest hydrocarbon potential, by means of passive seismic spectroscopy anomalies.

The survey has been designed based on the existing geological and geophysical data, remote sensing and gas soil sample analysis which supports the interpretation of oil accumulations in several large structures mapped on legacy gravity, seismic and magnetic data. Their interpretation of existing geological and geophysical data allowed the identification of three areas with high potential for oil and gas.

1.3.2 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$1.5 million per Degree Square Block per operator per year are 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 Oshikoto 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.

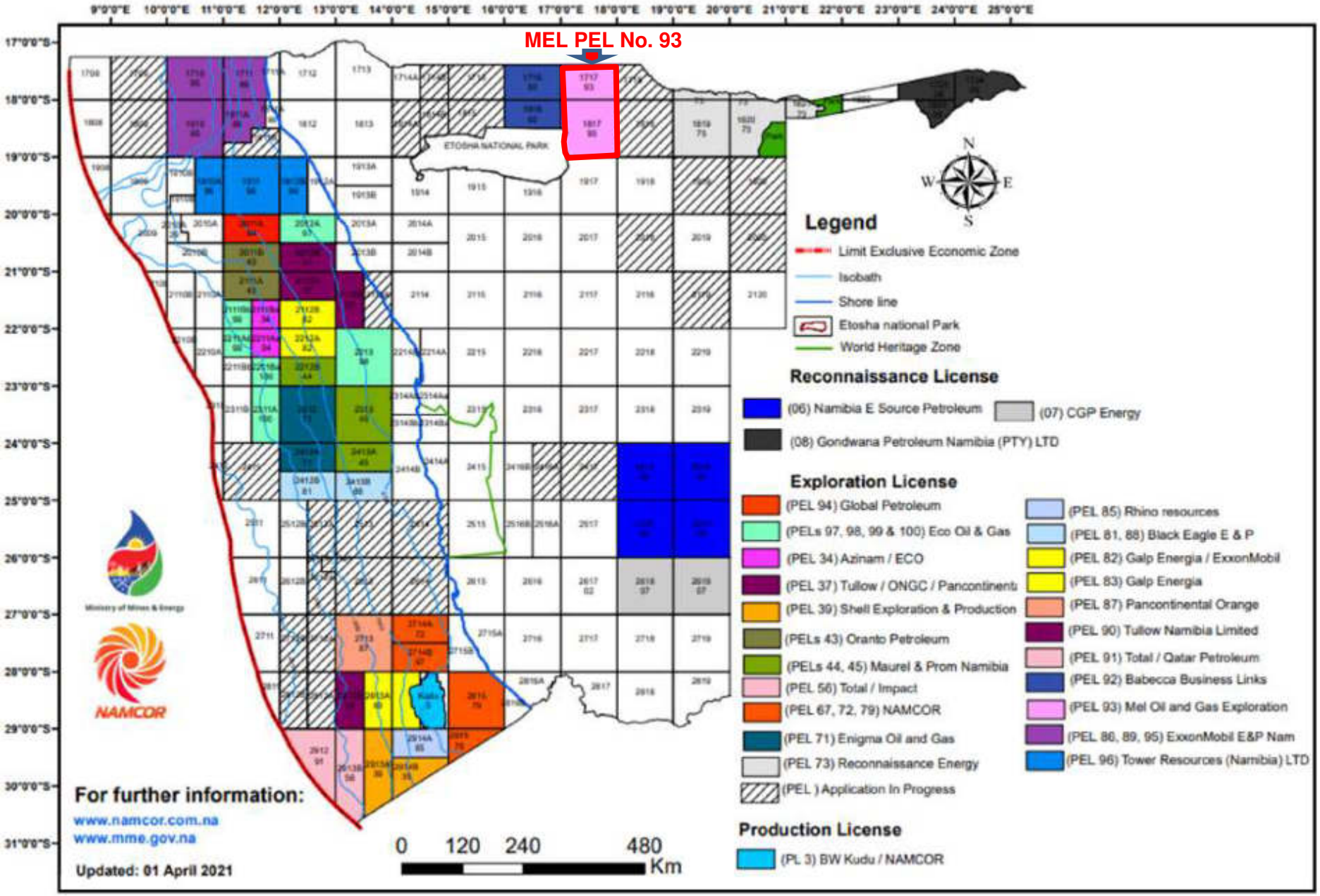


Figure 1.1: Hydrocarbon Map of Namibia (Source: www.mme.gov.na). Petroleum Exploration Licenses (PELs) are granted as predetermined degree (Latitude and Longitude) Square Blocks and several such license have been granted both in the offshore and onshore environments. Plenty more blocks are open for anyone to apply if one has about N$1.2 million yearly payment to lease such an area from the State inclusive of all other required mandatory State contributions.

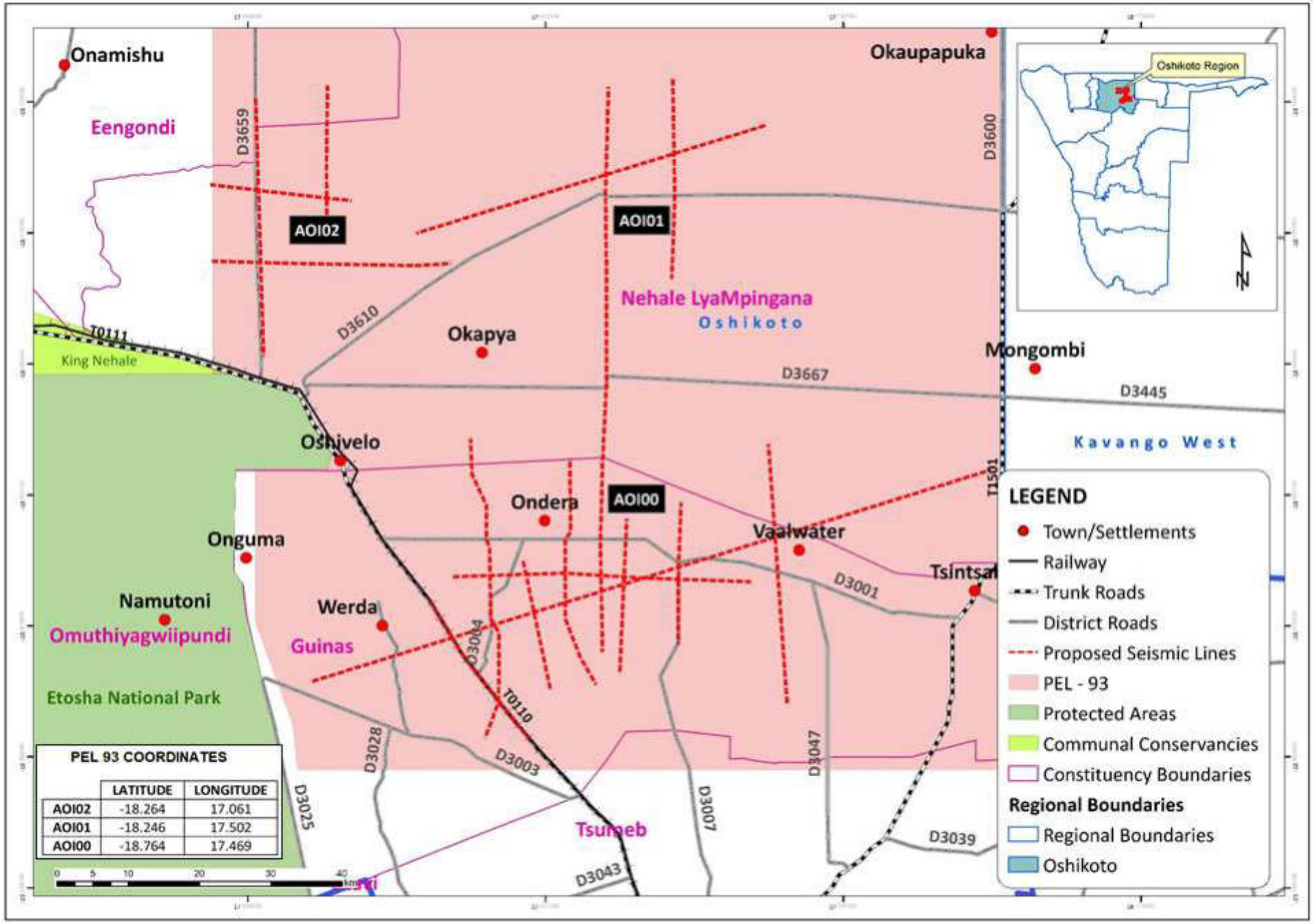


Figure 1.2: Regional location of PEL No. 93 covering degree square Blocks 1817 and 1717 showing the Areas of Interest (AOI), the proposed 2D seismic survey lines, regional council constituencies and traditional authorities' boundaries.

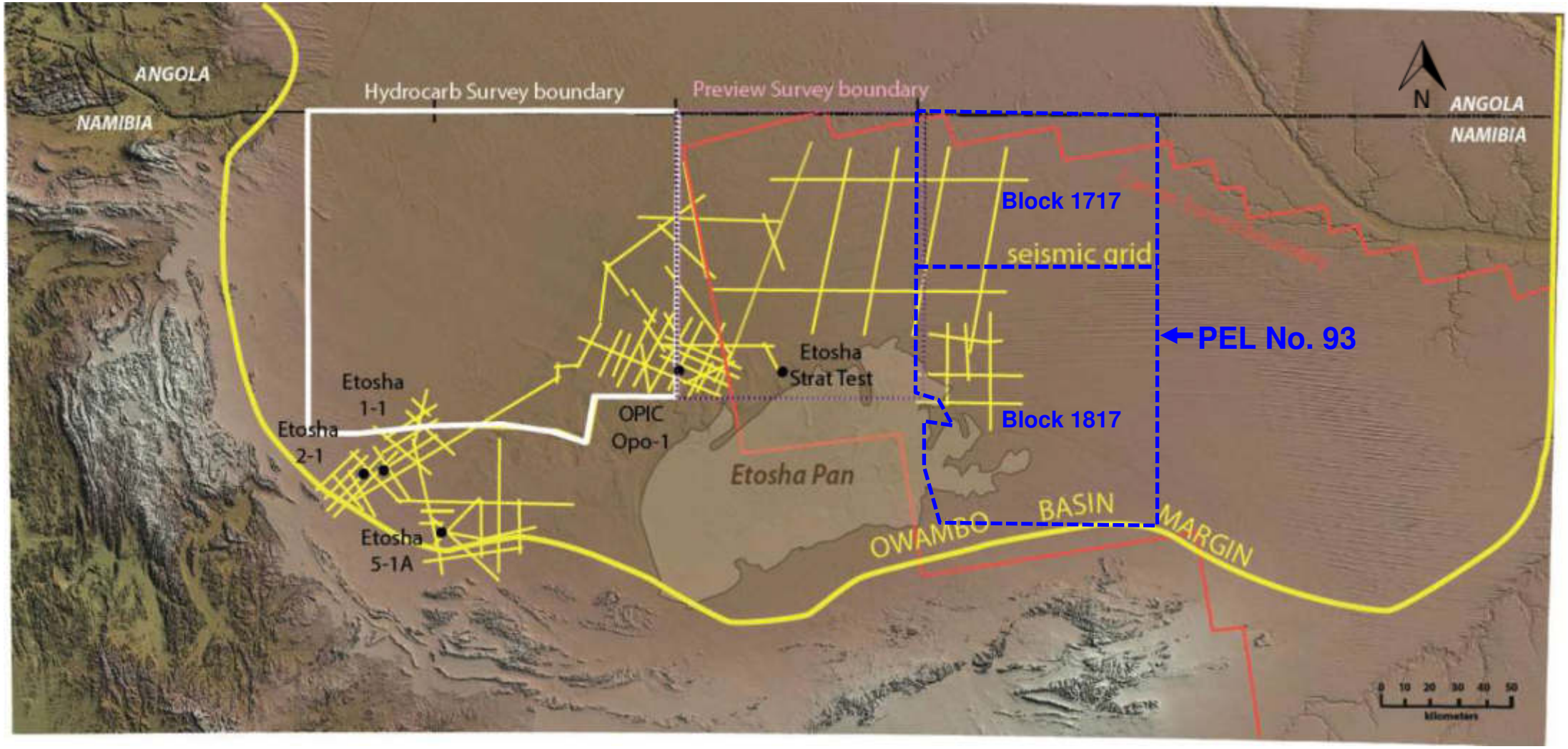


Figure 1.3: Digital elevation model of Owambo (Etosha) Basin showing the historical magnetic/gravity survey boundaries, seismic grid, and well locations with respect to MEL PEL No. 93 covering degree square Blocks 1817 and 1717. Multiple seismic survey operations have been successfully undertaken in the Owambo Basin and the proposed 2D seismic survey operations by MEL is not the first to be undertaken in the general area (Updated from base map Source: Hoak, *et. al.,* 2014).

1.3.3 Exploration Activities and Legal Relevance of the EIA Process

The proposed petroleum exploration activities (2D seismic Survey) by MEL requires an Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) to have been undertaken as provided under 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). An Environmental Clearance Certificate (ECC) is granted under the provisions of the Environmental Management Act, 2007, (Act No. 7 of 2007) and Environmental Impact Assessment (EIA) Regulations, 2012.

The scope of this Environmental Impact Assessment (EIA) only covers the proposed 2D seismic survey exploration activity linked to the current exploration authorisation (PEL 93) as granted by the Competent Authority, the Ministry of Mines and Energy. This EIA does not cover any future drilling, appraisal, or production phases. Currently, the Proponent does not have a Production License authorisation requiring an ECC triggering the need for a production phase EIA process as required under the Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991), and the Petroleum Laws Amendment Act, 1998, (Act 24 of 1998).

1.3.4 Strategic Environmental Assessments and Environmental Impact Assessment

1.3.4.1 Legal Screening and Comparative Overview

Strategic Environmental Assessment (SEA) is a high-level environmental assessment tool which provides for 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, the Ministry of Environment, Forestry and Tourism and the Ministry of Agriculture, Water and Land Reform 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 at project levels.

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) holding PELs, including MEL, falls within the lower level sphere of an EIA (Table 1.1).

Environmental Impact Assessment (EIA) on the other hand focuses on the downstream project level activities such as the ongoing exploration operations such as seismic survey or drilling that MEL as the Proponent is currently undertaking or planning to undertake within PEL 93.

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

ASSESSMENT TYPE	ACTIVITY FOCUS	RESPONSIBILITY	OUTPUTS
Strategic Environmental Assessment (SEA)	Policies Plans Programmes	Organs of State (Line Ministries such as MME, Parastatals, Regional Councils, Municipalities)	SEA Report with an Strategic Environmental Management Plan (SEMP)
Environmental Impact Assessment (EIA)	Project Specific Activity	Proponent (Private person, private entity such as MEL	EIA Report with an Environmental Management Plan (EMP)

1.3.4.2 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 practice 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 of a Policy, Plan or Programme of an Organ of State.

The responsibilities for the implementing an Environmental Plan / SEA are legally and exclusively reserved to the Organs of State such as Line Ministries, Agencies, Regional Councils and Larger Municipalities and it is not for the Proponents such as MEL. 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 might negatively affect the receiving 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), is 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 gazette 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).

1.3.4.3 EIA as an Appropriate Assessment Tool for MEL Exploration Activities

As shown in Table 1.1, MEL as a Proponent undertaking exploration operations in PEL 93 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 exploration activities as may be applicable. The activities of MEL do not fall at the high level of Policies, Plan or Programmes that are run by Organs of State and subject to an SEA but a lower project activity level run by Proponents and subject to EIA and EMP (Table 1.1).

MEL as a Proponent is under no obligation to undertake an SEA and the SEA will be irrelevant to a site-specific project level seismic survey or well drilling operations to be undertaken within a localised Area of Interest in PEL 93.

1.3.5 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 likely 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.

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

(i) Identify and 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.

(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 and to be detailed in the separate EMP report.

1.4 Detailed 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. 1.4).

It is the proximity of the AOI 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 2.5-4km.

At present, there is no oil or gas discovery within AOI and there is 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 operations before actual field development can even be contemplated. An oil and gas fields are usually a localised area within the entire AOI which is used for producing oil or gas (Fig. 1.4).

1.4.2 PEL 93 License Area

The PEL 93 which is granted as a Degree Square Blocks as provided for in the Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991) covers an area of approximately 18,500 sq. km (Figs. 1.5 and 1.6).

PEL No. 93 covering Blocks 1718 and 1818 falls within the Owambo Basin forming part of the greater Etosha Basin of northern Namibia falling within the greater Kalahari Sediments of Southern Africa, which also consists of the Etosha National Park, the largest protected wildlife sanctuary in Namibia cantered around Etosha Pan (Fig. 1.5).

1.4.3 Area of Interest (AOI) Within PEL 93

The Area of Interest (AOI) within PEL 93 delineated from the interpretation of the aerial geophysical data covers the Oshikoto and Ohangwena Regions. The proposed 2D seismic survey will cover the AOI and not the entire PEL 93 (Figs. 1.4-1.7). 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 (Figs. 1.5 and 1.6). The following is the summary of the detailed locations of the proposed 2D seismic survey lines shown in Fig. 1.7:

(i) **AOI-01 Northeast of Oshivelo**, covers 151 km of seismic over a large structure identified from gravity data. The objective is to acquire seismic data to define the structure within AOI01, specifically where Geochem shows encouraging anomalies.

(ii) **AOI-02 North of Oshivelo** covers about 108km, this will be defined and mapped out the closure of one of the structures within AOI02. The new seismic together with the existing seismic should be able to generate a prospect with positive Geochemical and Passive Seismic Surveys, and.

(iii) **AOI-00 large anticlinal structures South of Oshivelo,** covers 317km. The objective is to acquire seismic data to be able to generate a potential drillable target on AOI00, specifically where Geochemical and Passive Seismic Surveys have shown encouraging results.

Oshikoto Region borders the following regions: Ohangwena in the north, Kavango West in the east, Otjozondjupa in the south east, Kunene in the south west, and Oshana in the west. Within the key areas of interest, the following constituencies fall within the Oshikoto Region: Guinas, Nehale LyaMpingana, and Eengondi. The detailed locations of the proposed 2D seismic survey lines with respect to the regional and traditional authorities administrative / governance boundaries are shown in (Fig. 1.7).

1.4.4 Survey Lines Access

The main access to the survey area can be undertaken by 4x4 vehicles either through the already exiting gravel roads, sandy roads and tracks connecting small settlements (Figs. 1.5 -1.7). Except for Lines 5, 2, 8, and 15, totalling 105 km long, all the other proposed profiles / survey lines follow the existing roads or tracks and farm boundary fences (Figs. 1.5 - 1.7 and Plates 1.1 -1.40). 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 or protected trees shall be cut unnecessarily during the widening of existing access or creation of new cut lines if approved or requested by the land owners. The survey will be conducted towards the end of the 2nd quarter or the beginning of the 3rd quarter subject to the granting of authorisation or permits as may be required.

The following is the summary of the proposed seismic survey lines based on the results of the field-based scouting and verification undertaken by Risk-Based Solutions team during the months of January and February 2022 (Fig. 1.4-1.7 and Plates 1.1 -1.40):

1) Line 1 running along existing track, with drone images shown in Plates 1.1 -1.3.

2) Line 2 running along existing track, with drone images shown in Plates 1.4 and 1.5.

3) Line 3 running along existing track, with drone images shown in Plates 1.6 and 1.7.

4) Line 4 running along existing track, with drone images shown in Plates 1.8 – 1.11.

5) Line 5, no track exists, the line will have to be cut through pristine communal forest land, with drone images shown in Plates 1.12 and 1.13.

6) Line 6 running along existing track, with drone images shown in Plates 1.14 – 1.17.

7) Line 7 running along existing track, with drone images shown in Plates 1.18 and 1.19.

8) Line 8 no track exists, the line will have to be cut through pristine communal forest land, drone images shown in Plates 1.20 – 1.22.

9) Line 9 running along existing track, with drone images shown in Plates 1.23 – 1.26.

10) Line 10 running along existing track, with drone images shown in Plates 1.27 – 1.29.

11) Line 11 running along existing track, with drone images shown in Plates 1.30 – 1.32.

12) Line 12, no track exists, the line will have to be cut through pristine commercial farmlands, with drone image shown in Plate 1.33.

13) Line 13 running along existing track, with drone images shown in Plates 1.34 – 1.35.

14) Line 14 running along existing track, with drone images shown in Plates 1.36 and 1.37.

15) Line 15, no track exists, the line will have to be cut through pristine commercial farmlands, with drone images shown in Plate 1.38, and.

16) Line 16 running along existing track, with drone images shown in Plates 1.39 and 1.40.

1.4.5 New Cut Lines if Approved by the Land Owners

The creation of new cut lines for the proposed lines 5, 8, 12 and 15 will only be undertaken if such a proposal has been approved or requested by the affected land owner/s as part of the land management strategy such as wildfire management or needed for new access. The total length of the lines that may be created is 105 km. The creation of the cutlines shall be undertaken selectively and all mature and protected trees shall not be cut unnecessary and must be incorporated within the cutline profiles.

1.4.6 Need for Access Consent / Agreement

The following guidance on the need for access consents / agreements shall be observed:

1) In line with the provisions of all the national legislation, regulations, policies, procedures, permits / authorisations requirements and before the implementation of the proposed 2D seismic survey operations, the Proponent shall consult and engage the local communities / owners of commercial farms, communal fields and villages that may be affected or likely to be disturbed by the proposed project activities. All the consultations and engagements shall be undertaken through the existing regional and local structures starting with the Office of the Governor, Councillors, Traditional Authorities, Village Headpersons, communal / freehold land owners, and Village Development Committees (VDCs) and local community levels as may be applicable.

2) Before any form of field-based activities are started in a local area, written consent shall always be obtained from the land owners for private farmlands and through the village headperson, traditional authorities, and regional council / land board for communal land as may be applicable to avoid misunderstanding and unnecessary conflicts.

3) Appropriate setback distances (exclusion zones) shall be provided around sensitive structures such as villages, boreholes, water wells, dams, pipelines, burial grounds, cultural sites, irrigation canals and monuments / archaeological resources sites in line with the International Association of Geophysical Contractors (IAGC) and the Distance Requirements Exploration Directive 2006-15, Alberta Government, Canada guidelines, and.

4) Precautionary principles / approaches shall always be exercised especially in situations where specific mitigations, regulatory guidelines, standards, or appropriate setback distances (exclusion zones) around sensitive local cultural resources such as burial or cultural sites

have not been provided. Local communities shall always be consulted on matters related to sensitive local cultural resources not provided for in the international or national guidelines / standards/ EMP.

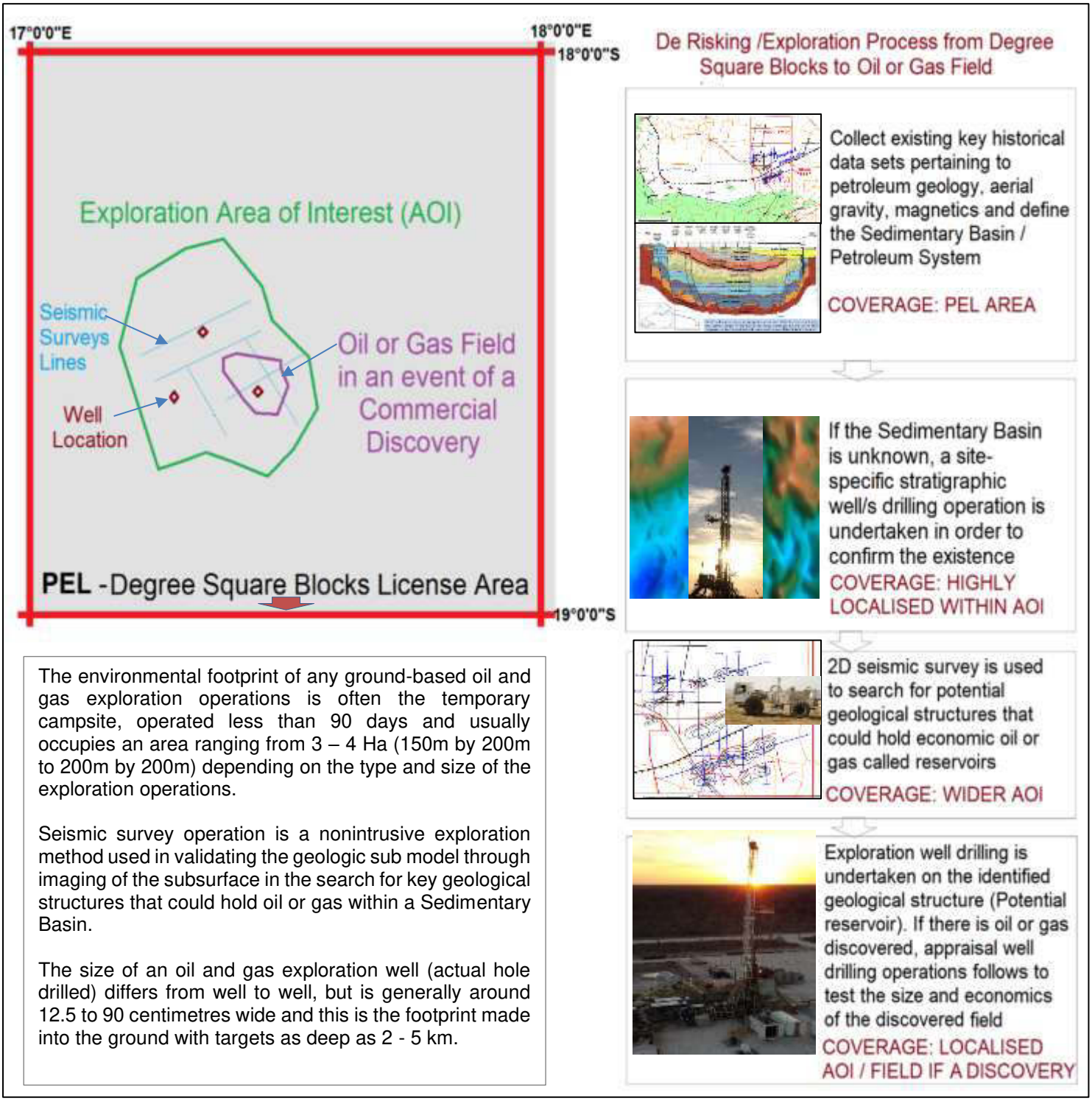


Figure 1.4: Illustration of the size and exploration footprint over a License Area (PEL) (subsurface rental area), Sedimentary Basin exploration Area of Interest (AOI), Sedimentary Basin seismic survey area, Sedimentary Basin drilling location and oil or gas field in an event of a commercial discovery with respect to the de-risking / exploration process.

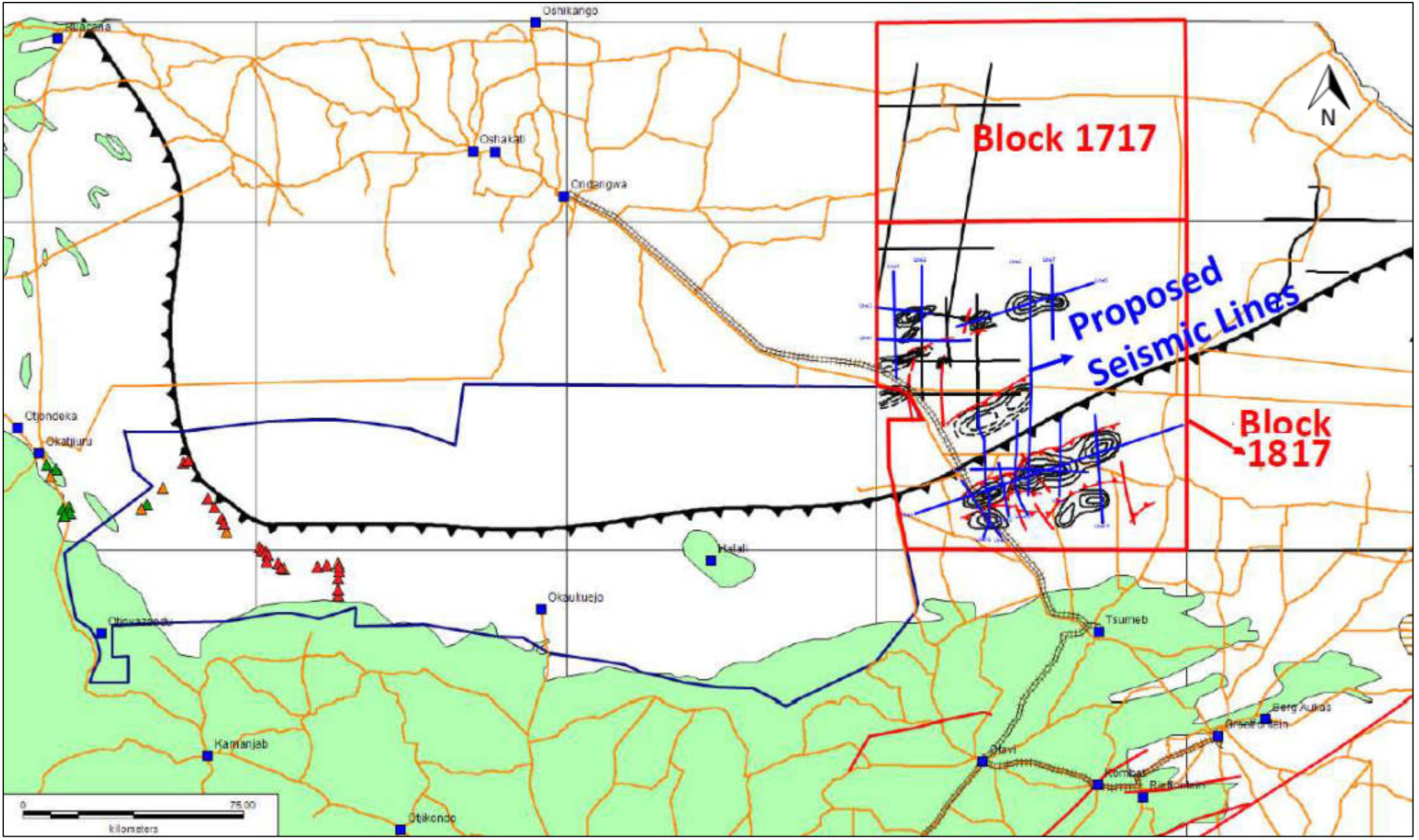


Figure 1.5: Regional overview of the License Area (PEL) 93, Blocks 1717 and 1817 license areas that make up PEL 93, (Areas of Interest (AOI) / prospect areas, proposed seismic survey lines (blue line) and existing / historical seismic survey lines (black lines).

AOI02	Line1	36	
	Line2	21	
	Line3	19	
	Line4	32	
			108
AOI01	Line5	49	
	Line6	77	
	Line7	25	
			151
AOI00	Line8	95	
	Line9	40	
	Line10 (Tie)	43	
	Line11	23	
	Line12	19	
	Line 13	33	
	Line14	26	
	Line15	37	
			317
		Total	576

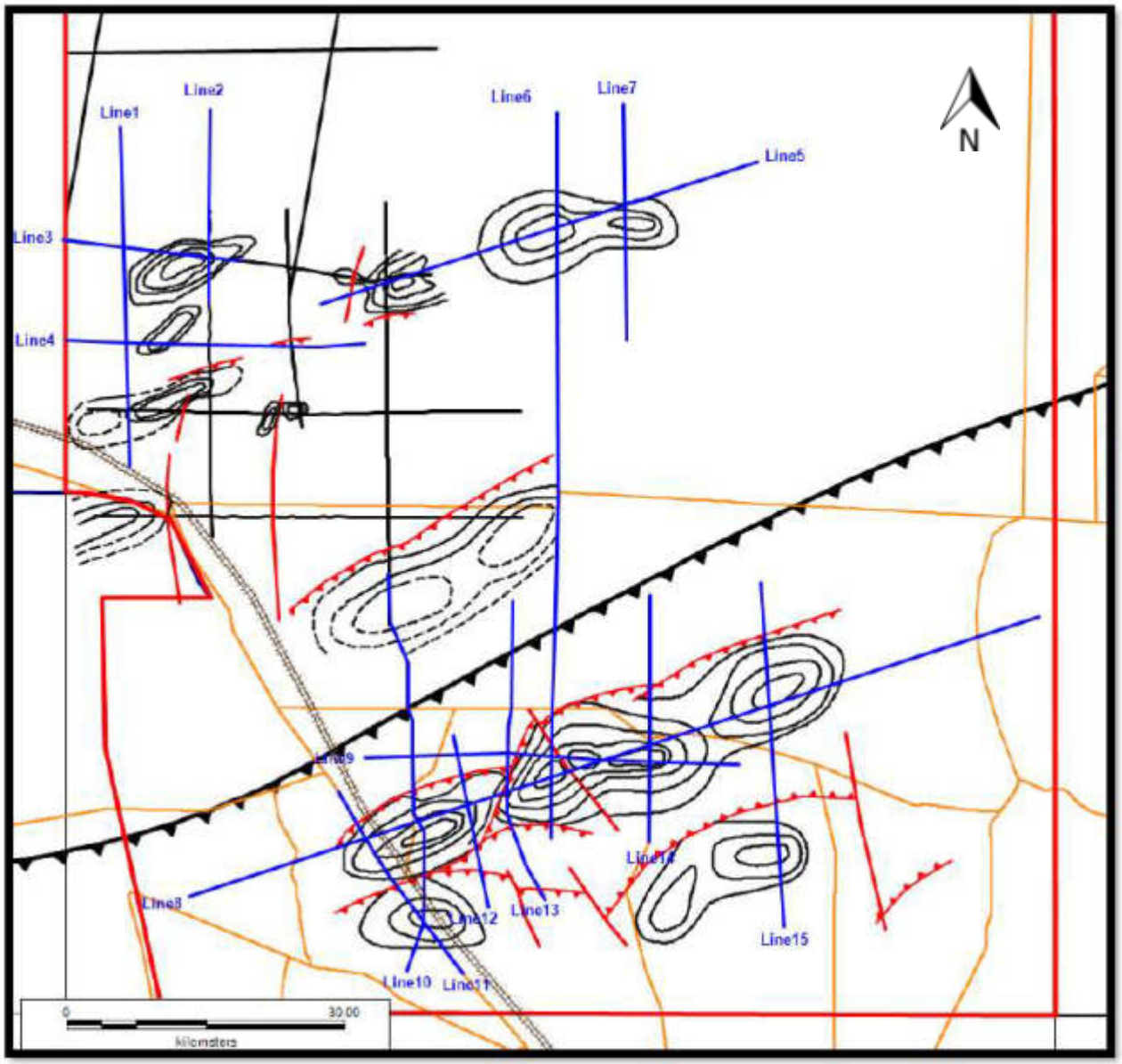


Figure 1.6: Detailed overview of the Block 1817 (part of PEL 93), Areas of Interest (AOI) / prospect areas AO102, AO101 and AO100, proposed seismic survey lines (blue line) and existing / historical seismic survey lines (black lines).

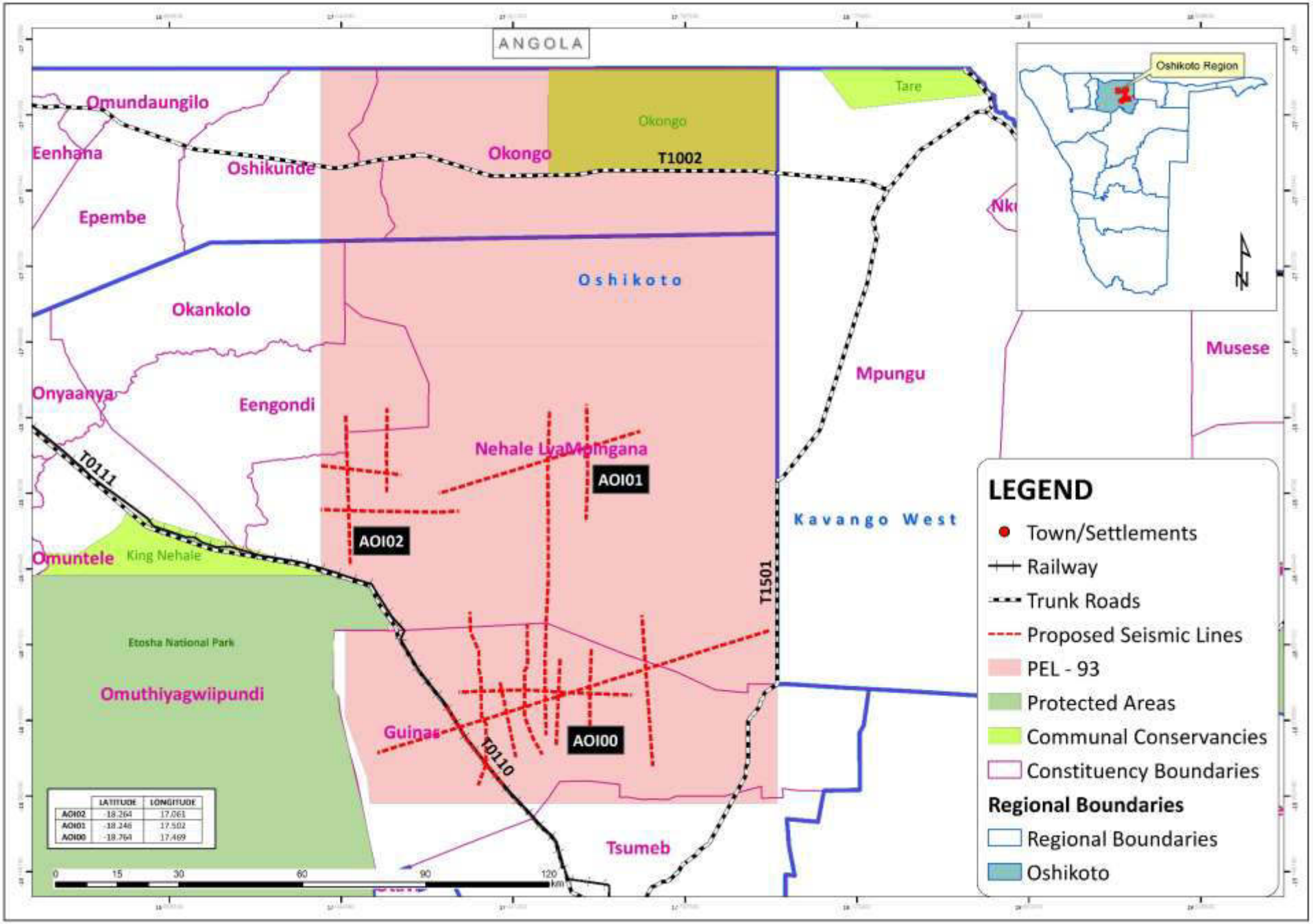


Figure 1.7: Detailed location of the Areas of Interest (AOI) - AOI01 and AOI02 and AOI00 and proposed 2D seismic survey lines with respect to the various regional boundaries.

Plate 1.1: Central part of Line 1 along existing track, drone image view to the north at the junction with western section of Line 4.

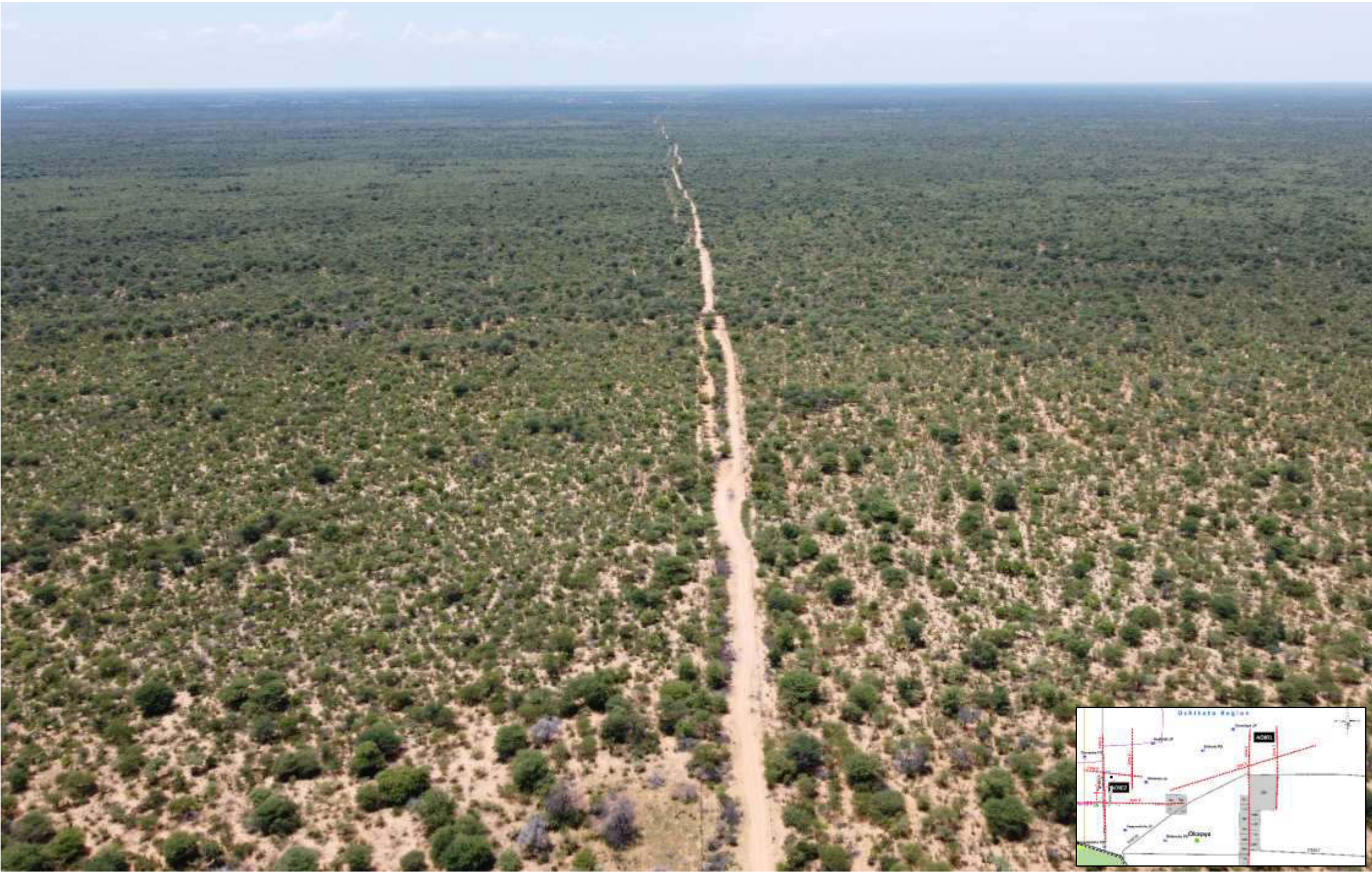


Plate 1.2: Central part of Line 1 along existing track, drone image view to the south at the junction with the western section Line 4.

Plate 1.3: Northern part of Line 1 along existing track, drone image view to the north at the junction with the western section Line 3.

Plate 1.4: Southern part of Line 2 along existing track, drone image view to the north at the junction with the eastern section of Line 3.

Plate 1.5: Southern part of Line 2 along existing track, drone image view to the south at the junction with the eastern section of Line 3.

Plate 1.6: Western part of Line 3 along existing track, drone image view to the east at the junction with the northern section of Line 1.

Plate 1.7: Southern part of Line 3 along existing track, drone image view to the east at the junction with the southern section of Line 2.

Plate 1.8: Western part of Line 4 along existing track, drone image view to the east at the junction with the southcentral section of Line 1.

Plate 1.9: Western part of Line 4 along existing track, drone image view to the west at the junction with Line 1.

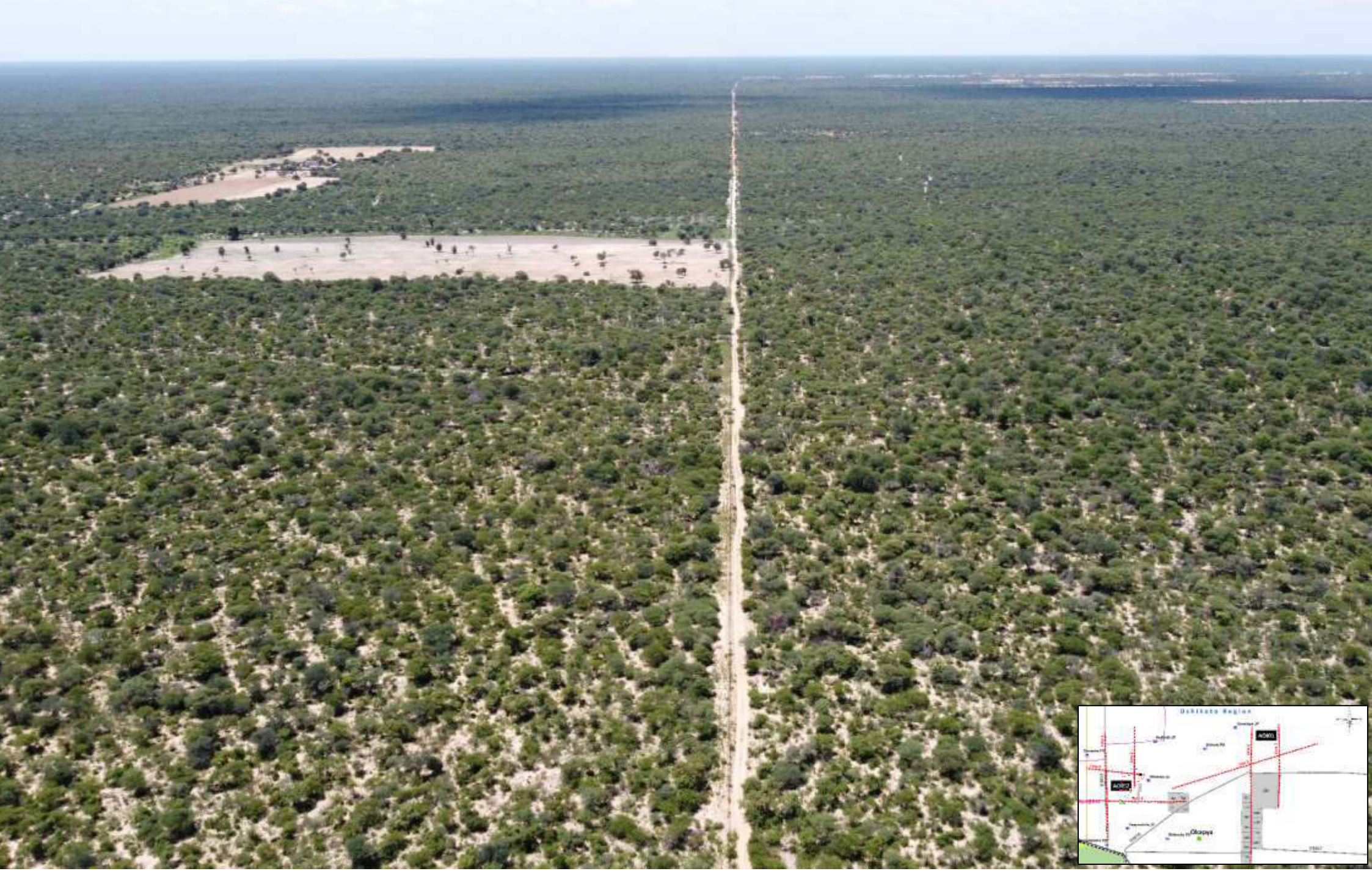


Plate 1.10: Western part of Line 4 along existing track, drone image view to the west at the junction with Line 1.

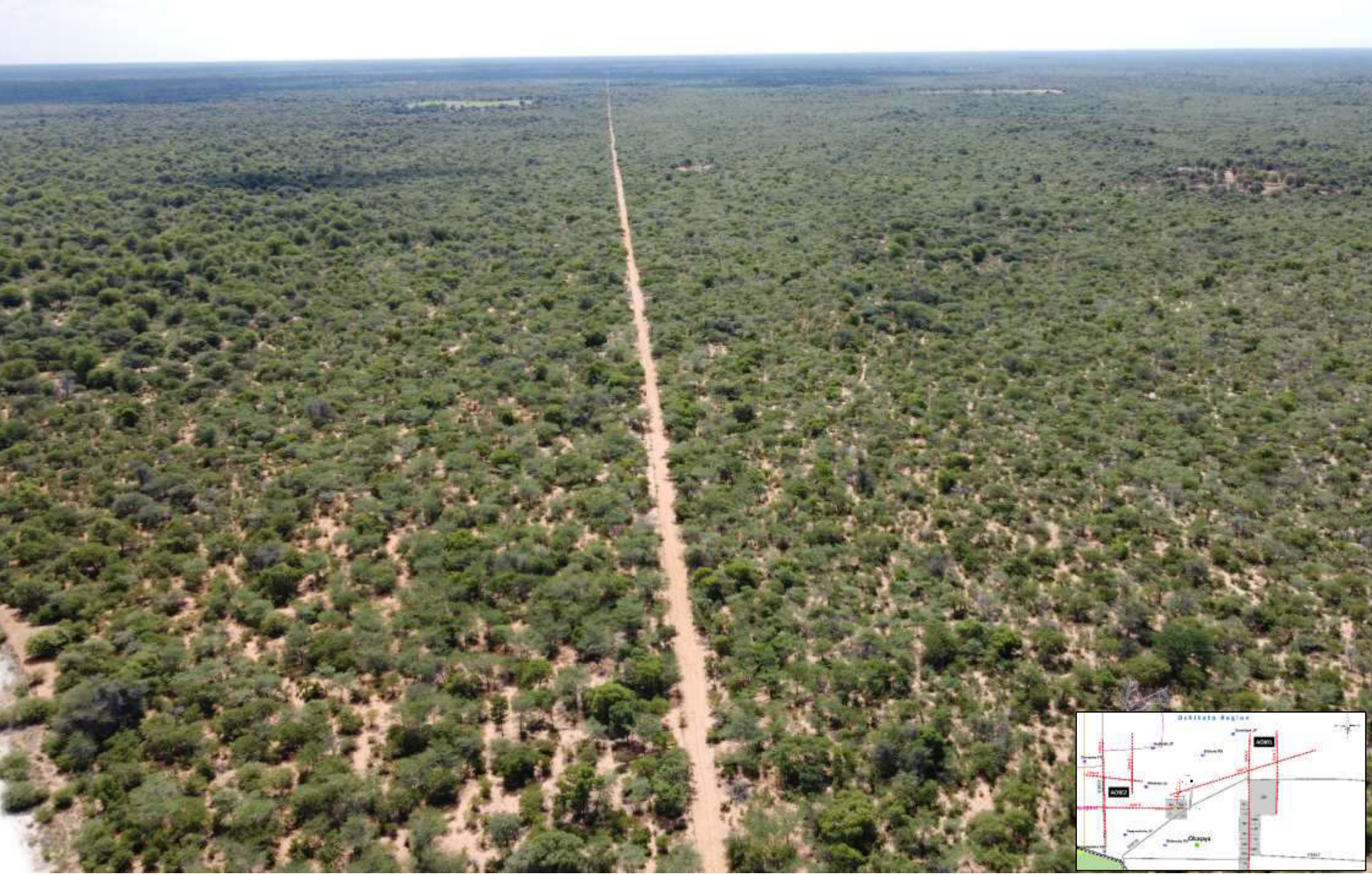


Plate 1.11: Eastern section of Line 4 along existing track, drone image view to the west from the D3610 Road.

Plate 1.12: Northeast central section of Line 5, drone image view to the southwest at the junction with the northern section of Line 6, no track exists, the line will have to be cut through pristine communal forest land.

Plate 1.13: Northeast central section of Line 5, drone image view to the northeast at the junction with the northern section of Line 6, no track exists, the line will have to be cut through pristine communal forest land.

Plate 1.14: Northern section of Line 6, drone image view to the north along the exiting track at the junction with the northeast central section of Line 5 that does not have an existing track, pristine forest.

Plate 1.15: Northern section of Line 6, drone image view to the south along the exiting track at the junction with the northeast central section of Line 5 that does not have an existing track, pristine forest.

Plate 1.16: Southern section of Line 6 along existing track, drone image view to the north along the D3001 road linking Oshivelo to Tsintsabis.

Plate 1.17: Southern section of Line 6 along existing track, drone image view to the south along the D3001 road linking Oshivelo to Tsintsabis.

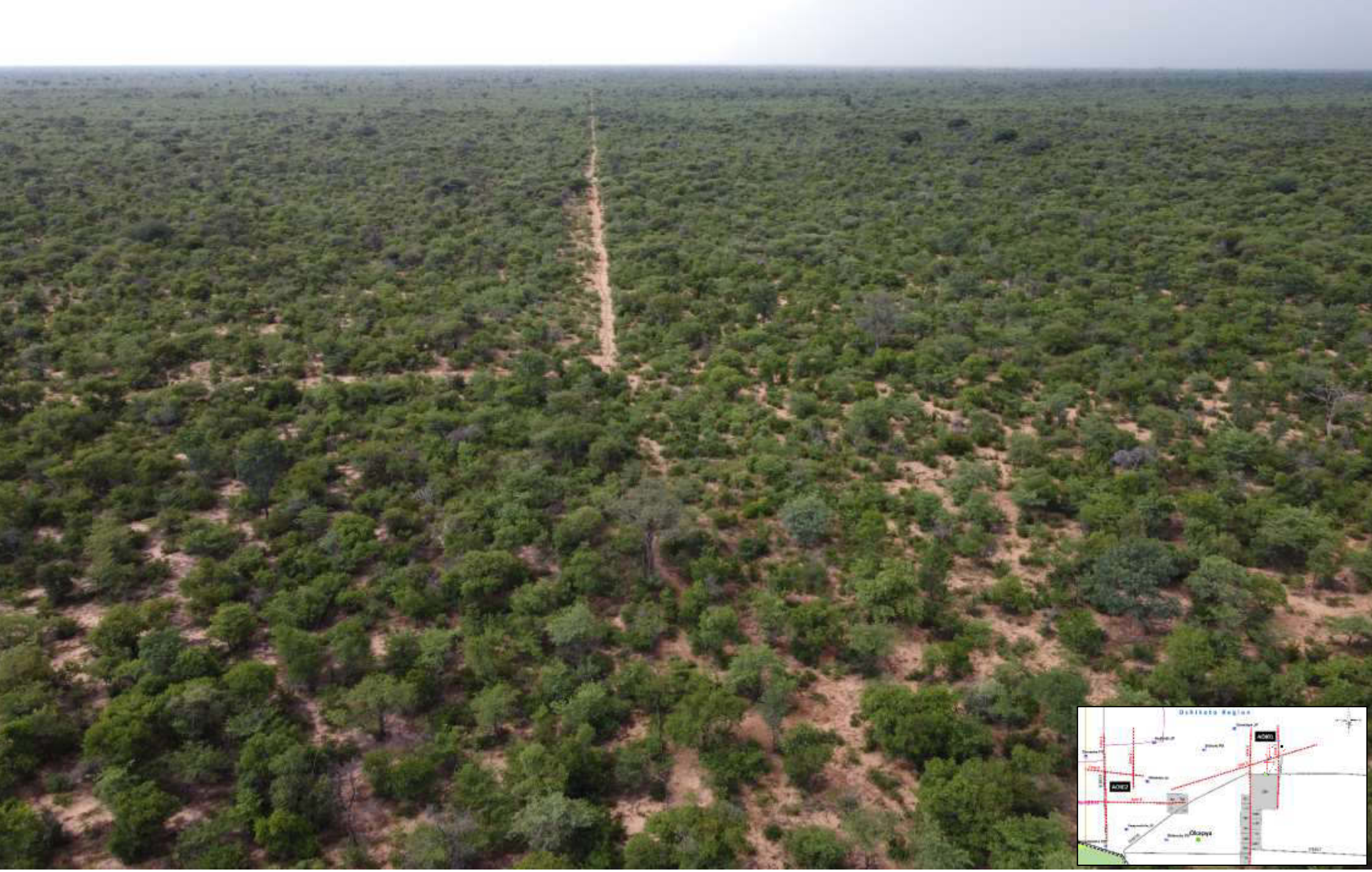


Plate 1.18: Eastern section of Line 7 along existing track, drone image view to the south from the D3610 Road.

Plate 1.19: Eastern section of Line 7 along existing track, drone image view to the north from the D3610 Road.

Plate 1.20: South western section of Line 8 running in pristine commercial farmlands with no existing track or farm fence access and the proposed line runs through the sensitive Onguma Game Reserve. Drone image view to the southwest taken at a junction with Line 11 along the B1 Road from Tsumeb to Oshivelo.

Plate 1.21: North eastern section of Line 8, no track exists and the proposed line runs through pristine commercial farmlands. Drone image view to the northeast taken at a junction with Line 11 along the B1 Road from Tsumeb to Oshivelo.

Plate 1.22: North-eastern section of Line 8, running along existing track, drone image view to the east taken at the junction of Line 14 running along the D3007 Road to Tsumeb and the D3001 road linking Oshivelo to Tsintsabis.

Plate 1.23: Western section of Line 9, running along existing track, drone image view to the west taken along the D3004 connecting the B1 Road from Tsumeb to Oshivelo to the D3001 road linking Oshivelo to Tsintsabis.

Plate 1.24: Western section of Line 9, running along existing track, drone image view to the east taken along the D3004 connecting the B1 Road from Tsumeb to Oshivelo to the D3001 road linking Oshivelo to Tsintsabis.

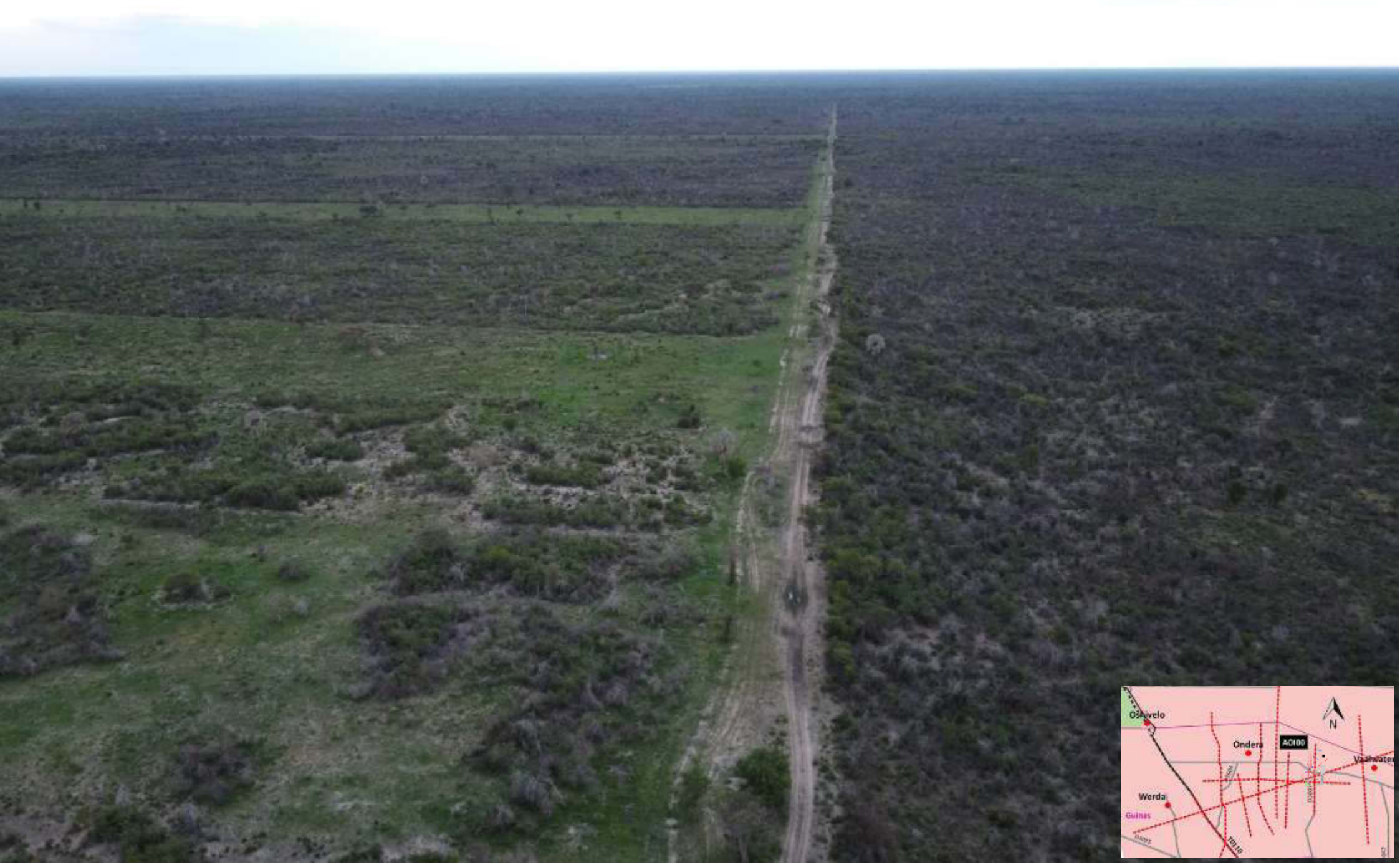


Plate 1.25: Eastern section of Line 9, running along existing track, drone image view to the east taken along the D3007 to Tsumeb and comes off the D3001 road linking Oshivelo to Tsintsabis.

Plate 1.26: Eastern section of Line 9, running along existing track, drone image view to the west taken along the D3007 to Tsumeb and comes off the D3001 road linking Oshivelo to Tsintsabis.

Plate 1.27: Northern section of Line 10, running along existing track, drone image view to the north taken along the D3001 road linking Oshivelo to Tsintsabis.

Plate 1.28: Central section of Line 10, running along existing track, drone image view to the north taken at a junction with Line 11 along the B1 Road from Tsumeb to Oshivelo.

Plate 1.29: Southern section of Line 10, running along existing track, drone image view to the south taken at a junction with Line 11 along the B1 Road from Tsumeb to Oshivelo.

Plate 1.30: Southern section of Line 11, running along the B1 Road from Tsumeb to Oshivelo, drone image view to the north.

Plate 1.31: Central section of Line 11, running along the B1 Road from Tsumeb to Oshivelo, drone image view to the north taken at the junction of Line 11 and Line 10.

Plate 1.32: Northern section of Line 11, running along the B1 Road from Tsumeb to Oshivelo, drone image view to the north taken at the junction between Line 11 and 8.

Plate 1.33: Central section of Line 12, running in pristine commercial farmlands with no existing track or farm fence access, drone image view to the east taken along a track that comes of the D3004 Road.

Plate 1.34: Northern section of Line 13, running along existing track, drone image view to the north taken along the D3001 road linking Oshivelo to Tsintsabis.

Plate 1.35: Southern section of Line 13, running along existing track, drone image view to the north taken along the D3001 road linking Oshivelo to Tsintsabis.

Plate 1.36: Southern section of Line 14, running along existing road D3007 to Tsumeb, drone image view to the south taken at the junction of the D3001 road linking Oshivelo to Tsintsabis and the D3007.

Plate 1.37: Northern section of Line 14, running along existing track, drone image view to the north taken at the junction of the D3001 road linking Oshivelo to Tsintsabis and the D3007.

Plate 1.38: Line 15, running in pristine commercial farmlands with no existing track or farm fence access.

Plate 1.39: Northern section of Line 16, running along existing track, drone image view to the north taken along the D3001 road linking Oshivelo to Tsintsabis.

Plate 1.40: Northern section of Line 16, running along existing track, drone image view to the north taken along the D3001 road linking Oshivelo to Tsintsabis.

1.5 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 MEL 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 adopted in the preparation of this EIA report.

- **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.

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

- **Section 7: EIA Conclusions and 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 with 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>
<tr><th>PROPOSED 2D SEISMIC SURVEY PROJECT ACTIVITIES TO BE UNDERTAKEN WITH THE PERMISSIONS OF LAND OWNERS.</th><th>ALTERNATIVES CONSIDERED</th><th colspan="2">KEY ISSUES TO BE EVALUATED AND ASSESSED IN THE EIA REPORT WITH MITIGATION MEASURES TO BE PROVIDED IN THE ENVIRONMENTAL MANAGEMENT PLAN (EMP) REPORT</th></tr>
<tr><td rowspan="5">(i) Planning and mobilisation (Pre-survey preparation, field scouting and mapping of buffers and offsets along proposed survey lines).
(ii) Base camp and fly-camps site setups and operations.
(iii) Widening of existing tracks and farm fences access by pruning vegetation overgrowth and tracks levelling as may be applicable.
(iv) Creating access across various farm fences and fixing of affected fences immediately after the survey / data acquisition drive through.
(v) Creation of new access for current and possible future infill survey.
(vi) Actual survey operation (data acquisition).
(vii) Demobilisation and closure (Survey Completion), and.
(viii) Any accidental event that may be associated with the routine and physical presence operational activities.</td><td rowspan="5">(i) Survey location with respect to the PEL and Area of Interest (AOI)
(ii) Profiles / survey lines length and location
(iii) Energy source (Vibroseis, Explorer 860 or dynamite)
(iv) Receivers / Geophones (Wireless or Cabled)
(v) No-Action alternative, proposed survey not going ahead
(vi) Other alternative land, roads, tracks and new cutlines uses
(vii) Ecosystem Function (What the Ecosystem Does)
(viii) Ecosystem Services
(ix) Use Values
(x) Non-Use, or Passive Use
(xi) The No-Action Alternative</td><td colspan="2">Potential land use conflicts / opportunities for coexistence between proposed exploration and other existing land uses such as agriculture, conservation and tourism</td></tr>
<tr><td>Physical Environment</td><td>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.</td></tr>
<tr><td>Biological Environment</td><td>1. Habitat
2. Protected areas and resources
3. Flora
4. Fauna
5. Ecosystem functions, services, use values and non-use or passive use.</td></tr>
<tr><td>Socioeconomic, cultural, and archaeological environment</td><td>1. Local, regional, and national socioeconomic settings
2. Subsistence agriculture
3. Community forest
4. Tourism and recreation
5. Cultural, biological, and archaeological resources</td></tr>
<tr><td>Environmental Management Plan (EMP) Providing Mitigation Measures and Monitoring Plan</td><td>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.</td></tr>
</table>

2.2 Summary Overview of the EIA Methodology

The Environmental Assessment process for this project has been undertaken in accordance with the applicable regulations and assessment procedures as detailed in Fig. 2.1. The assessment process took into considerations MEL 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 exploration operations.

All the applicable national regulations, the corporate requirements of the Proponent, oil and gas exploration and environmental assessment international best practices, and sensitivity of the receiving environment (physical, biological, socioeconomic and ecosystem services and functions).

The following is the summary of the adopted environmental assessment approach:

- Undertook scoping (determination of geographical and other boundaries, preliminary assessment).
- Reviewed the existing regulatory framework and institutional arrangements.
- Local community and stakeholder mapping and pre-consultation for the local community, traditional authorities, and regional leadership.
- Undertook community consultation process as part of the 2D seismic survey which allowed local communities to see and understand the equipment to be used.
- Undertook field verifications and detailed field-based environmental assessments.
- Reporting, impact identification and development of suggested mitigation measures, and.
- Reporting, development of an EMP with roles and responsibilities.

Prior to the field study, desktop studies were conducted to review the 2D seismic survey EIA reports, and to design plans and maps to compile relevant biophysical and socioeconomic information of the project area (Annex 1).

Biophysical studies covered environmental aspects such as physiography, climate, hydrology, drainage, soils, geology/hydrogeology, land use, vegetation, wildlife, and socioeconomic environment were also reviewed as applicable.

2.3 Summary of the Environmental Assessment Process

2.3.1 Summary of the Assessment Step

The EIA and EMP process to be used for this project will take 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. 5.1):

(i) Project screening process (**Undertaken in January 2022**).

(ii) Preparation of the Draft BID/Draft Scoping Report with Terms of Reference (ToR) for review by the Proponent (**Undertaken in January 2022, Annex 1**).

(iii) Preparation of the Public Notice published in the local newspapers as part of required public consultation process (**Undertaken in February 2022**).

(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 (**To be Undertaken in March 2022**).

(v) Opened the Stakeholder register (**Undertaken in 21st February 2022**).

(vi) Invitation / notices to stakeholders and the 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 February 2022 for a period of 21 days from the 1st publication published on the February 2022**).

(vii) Preparation of the Draft EIA and EMP Reports (**Undertaken in February and March 2022**).

(viii) Preparation of the Final EIA and EMP Reports (**Undertaken in March and April 2022**).

(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 (**April 2022)**.

(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 projects are 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 April 2022)**.

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 this 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.

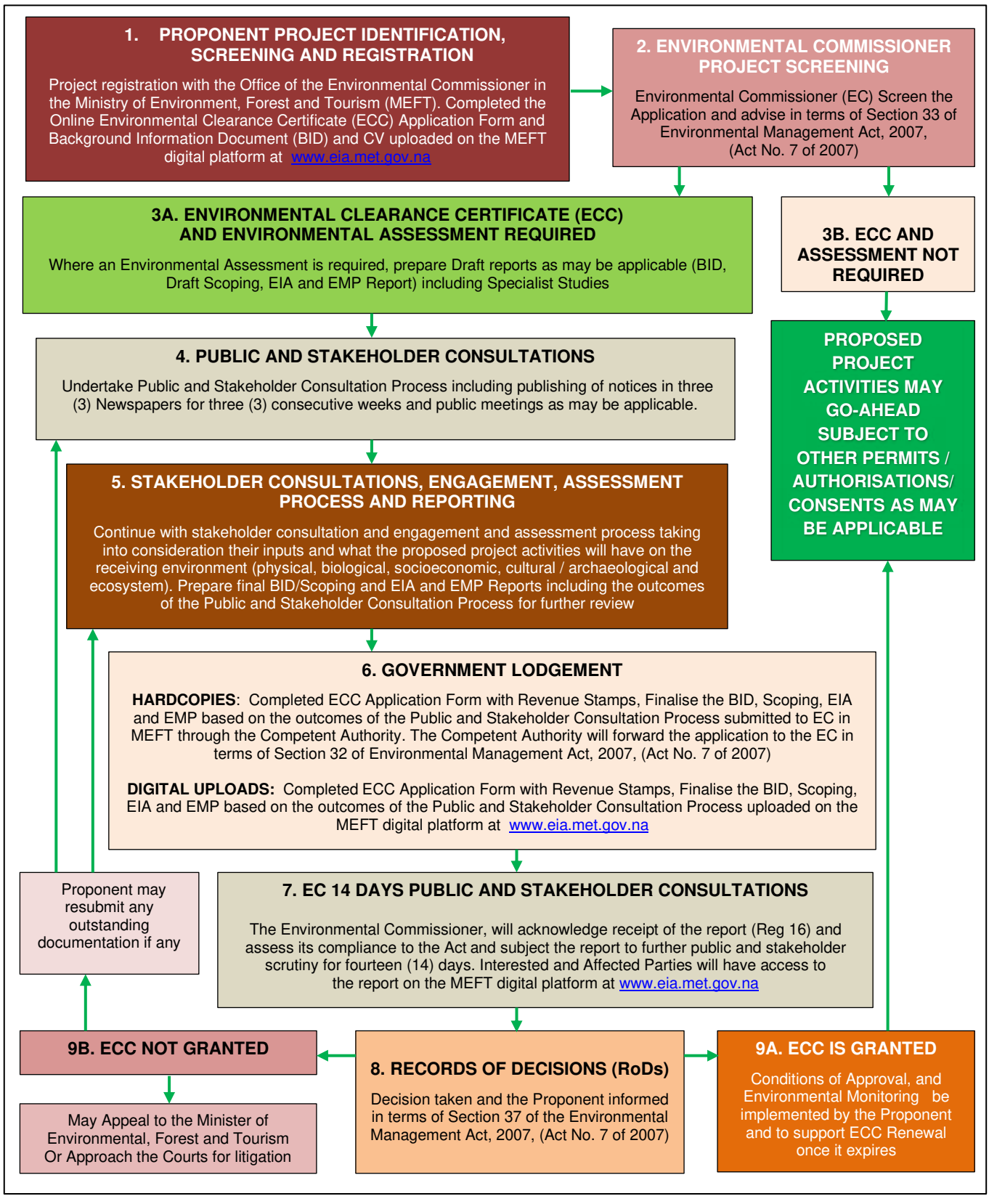


Figure 2.1: RBS Schematic presentation of Namibia's Environmental Assessment Procedure.

2.4 Impact Assessment Process

2.4.1 Overview

The overall impact assessment adopted a matrix framework like the Leopold matrix which is one of the internationally best-known impact assessment methodology available for predicting the impact of a project on the receiving environment. The assessment process took into consideration the proposed activities, trade-offs, alternatives, and issues to be considered as assessed in this EIA Report.

2.4.2 Individual Components Impact Assessment Criteria

Based on the Terms of Reference and overall outcomes of the 2D seismic survey EIA study, all key components of the receiving environment were identified and assessed with respect to the proposed 2D seismic survey operations.

2.4.3 Overall Component and Significant Impact Assessment

2.4.3.1 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 consideration, 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 2.2 for magnitude, Table 2.3 for duration and Table 2.4 for extent.

Table 2.2: Scored on a scale from 0 to 5 for impact magnitude.

SCALE (-) or (+)		DESCRIPTION
0		no observable effect
1		low effect
2		tolerable effect
3		medium high effect
4		high effect
5		very high effect (devastation)

Table 2.3: Scored time over which the impact is expected to last.

SCALE (-) or (+)		DESCRIPTION
T		Temporary
P		Permanent

Table 2.4: Scored geographical extent of the induced change.

SCALE (-) or (+)		DESCRIPTION
L		limited impact on location
O		impact of importance for municipality.
R		impact of regional character
N		impact of national character
M		impact of cross-border character

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 2.5. Likelihood of an impact occurring 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 2.5: Summary of the qualitative scale of probability categories (in increasing order of likelihood).

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

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 2.6 and the results are presented in this report under Chapter 6.

2.4.3.2 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 such as the intensity and duration of the likely negative impact as assessed under individual components likely to be impacted (Table 2.6).

The assessment focused on the degree to which the proposed project activities are likely to result 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 has been assessed and presented as shown in Table 2.7 with the results provided in this report under Chapter 6.

Table 2.6: 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.

RECEIVING ENVIRONMENT SENSITIVITY

SENSITIVITY RATING		CRITERIA
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				PHYSICAL ENVIRONMENT						BIOLOGICAL ENVIRONMENT					SOCIOECONOMIC, CULTURAL, AND ARCHAEOLOGICAL ENVIRONMENT				
				Water Quality	Physical infrastructure and Resources	Air Quality, Noise and Dust	Landscape Topography	Soil Quality	Climate Change Influences	Habitat	Protected Areas	Flora	Fauna	Ecosystem functions, services, use values and non-Use or passive use	Local, regional, and national socioeconomic settings	Subsistence Agriculture	Community Forest	Tourism and Recreation	Cultural, Biological and Archaeological Resources
	ROUTINE AND PHYSICAL PRESENCE OPERATIONAL ACTIVITIES	1.	Planning and mobilisation (Pre-survey preparation, field scouting and mapping of buffers and offsets along proposed survey lines)																
		2.	Base camp and fly-camps site setups and operations																
		3.	Widening of tracks by pruning vegetation overgrowth and tracks levelling as may be applicable																
		4.	Creation of new access especially cutting of new cutlines with the permissions of the land owners to be used for data acquisition																
		5.	Actual survey operation (data acquisition).																
		6.	Demobilisation and closure (Survey Completion)																
	UNPLANNED ACCIDENTAL EVENTS	7.	Any accidental event that may be associated with the routine and physical presence operational activities																

Table 2.7: 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).

IMPACT SEVERITY (Magnitude, Duration, Extent, Probability)	RECEPTOR CHARACTERISTICS (SENSITIVITY)				
	Very High (5)	High(4)	Medium (3)	Low (2)	Negligible (1)
Very High (5)	Major [5/5]	Major [4/5]	Moderate [3/5]	Moderate [2 /5]	Minor 1/5
High (4)	Major [5/4]	Major [4/4]	Moderate [3/4]	Moderate [2/4]	Minor[1/4]
Medium (3)	Major [5/3]	Moderate[4/3]	Moderate[3/3]	Minor[2/3]	None[1/3]
Low (2)	Moderate [5/2]	Moderate[4/2]	Minor[3/2]	None[2/2]	None[1/2]
Negligible (1)	Minor [5/1]	Minor [4/1]	None [3/1]	None [2/1]	None [1/1]

				PHYSICAL ENVIRONMENT						BIOLOGICAL ENVIRONMENT					SOCIOECONOMIC, CULTURAL, AND ARCHAEOLOGICAL ENVIRONMENT				
				Water Quality	Physical infrastructure and Resources	Air Quality, Noise and Dust	Landscape Topography	Soil Quality	Climate Change Influences	Habitat	Protected Areas	Flora	Fauna	Ecosystem functions, services, use values and non-Use or passive use	Local, regional, and national socioeconomic settings	Subsistence Agriculture	Community Forest	Tourism and Recreation	Cultural, Biological and Archaeological Resources
SOURCES OF POTENTIAL IMPACT	**ROUTINE AND PHYSICAL PRESENCE OPERATIONAL ACTIVITIES**	1.	Planning and mobilisation (Pre-survey preparation, field scouting and mapping of buffers and offsets along proposed survey lines)																
		2.	Base camp and fly-camps site setups and operations																
		3.	Widening of tracks by pruning vegetation overgrowth and tracks levelling as may be applicable																
		4.	Creation of new access especially cutting of new cutlines with the permissions of the land owners to be used for data acquisition																
		5.	Actual survey operation (data acquisition).																
		6.	Demobilisation and closure (Survey Completion)																
	UNPLANNED ACCIDENTAL EVENTS	7.	Any accidental event that may be associated with the routine and physical presence operational activities																

2.5 Mitigation Measures for Significance Impacts

2.5.1 Overview

Based on the findings 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.

2.5.2 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.

2.5.3 Monitoring and Reporting Guiding Principles

The environmental performance monitoring process to be provided for in the 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 SUMMARY

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 environmental 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 material, initiates the process of cooking. If the sedimentary rock has enough organic material 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 gets deposited within the Sedimentary basin, 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 basin that cooks the oil or gas and 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 corresponds 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 (source rock), there is no guarantee that the food will still be in dining room because maybe someone was already in dining room and has eaten all or much of the food and this is like 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 to the high pressure created by the weight of the overlaying materials. When oil and / or gas is flushed out of the source rocks, it can migrate in the downward or upward directions along favourable and porous geological horizons and structural discontinuities. Such faults or bedding planes and accumulation takes place 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 – 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 in a reservoir with limited connectivity abilities and requiring fracking to produce or pump it.

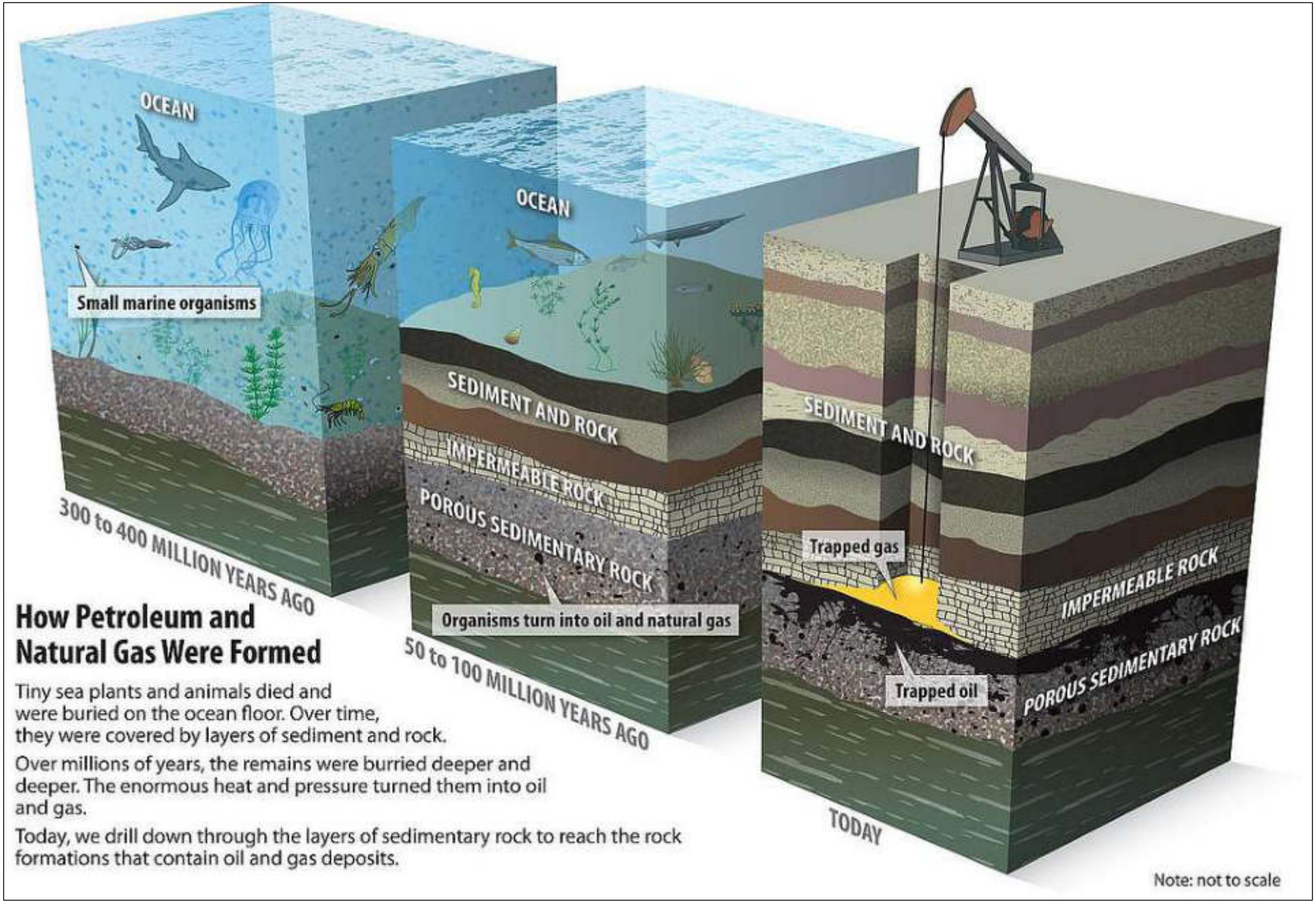


Figure 3.1: Illustration on how oil and gas are formed over millions of years (Source:https://letslearngeology.wordpress.com/oil-formation-petroleo/).

3.2 Understanding Petroleum (Oil and Gas) Exploration

Oil and gas exploration is indeed an expensive journey with uncertain known destination and if one compares it to say a journey from Windhoek to Oshivelo, MEL oil and gas exploration 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 Oshivelo, MEL 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 Oshivelo 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 unconventional 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 the form of a Sedimentary Basin with potential to host source rocks and reservoir structures with theoretically assumed boundary conditions 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 sells 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 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 on the exploration process (2D seismic survey).

5. 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.

6. 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.

7. The economic evaluation is a 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 Seismic Survey as an Exploration Method

3.3.1 Basic Principles of 2D Ground Seismic Survey

Onshore 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 travels into the earth and get reflected by various rock layers of the subsurface formations, and returns to the surface where it is recorded by receivers called geophones which are like microphones (Fig. 3.2).

The proposed 2D seismic survey will either use Explorer 860 Accelerated Weight Drop (AWD) or a Nomad 65 Vibrator as the energy sources and will utilise wireless receivers that will allow for greater line offsets. The rear mounted weight-drop from the Explorer 860 or the centred vibrating metal plates from the Nomad 65 will each generates acoustic / sound waves that will penetrate deep into the ground below the survey and bounced off the various subsurface rock layers (Fig. 3.2). Receivers installed along the survey lines at between 5 – 10 m station intervals will measure the returning sound / acoustic wave and then recorded by a device called a seismograph. 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) (Figs. 3.2 and 3.3). The interpreted 2D seismic survey data sets is used to find specific drilling locations where potential reservoirs within the AOI oil or gas may be trapped in sufficient commercial quantities.

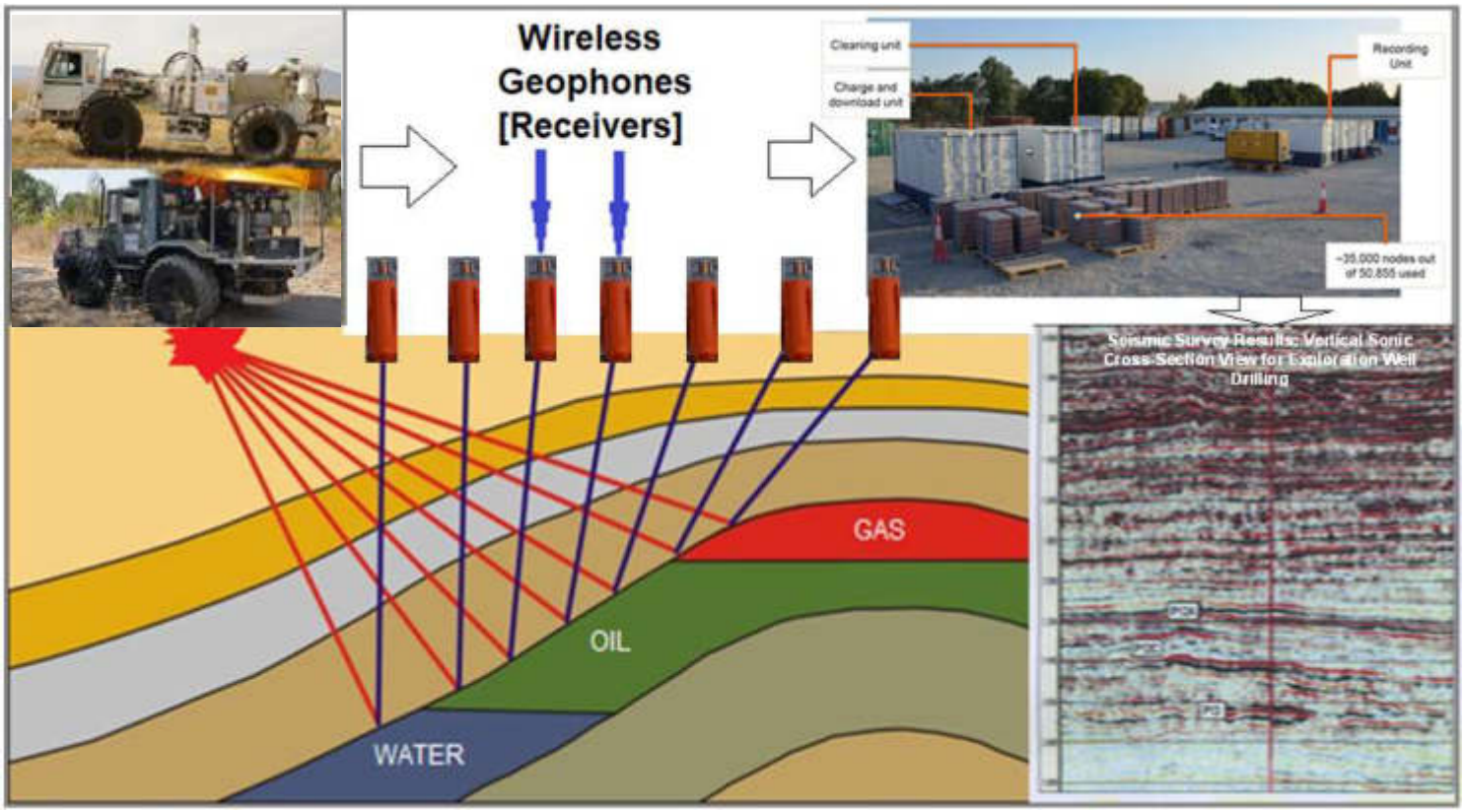


Figure 3.2: Illustration of the 2D ground seismic survey operations (Photos Source: http://www.polarisexplorer.com).

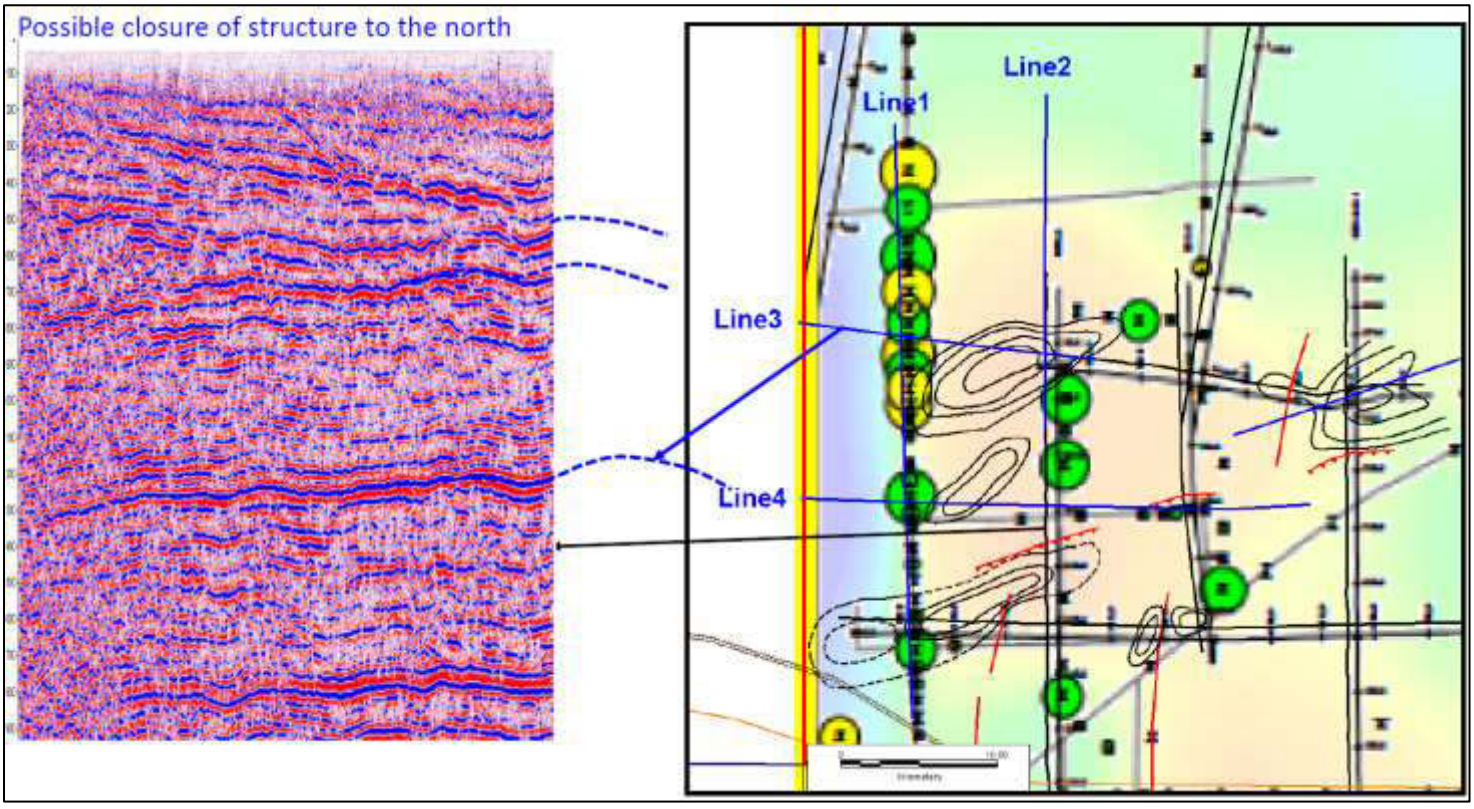


Figure 3.3: Example of the resultant product following complex processing of 2D seismic survey data showing a vertical sonic cross-section of the subsurface beneath the survey lines showing the geological structures and associated characteristics favourable for holding economic oil and gas resources and to be validated through exploration well drilling operations (de-risked geological sub-model) (Source: MEL, 2022).

3.3.2 Types of Energy Sources

3.3.2.1 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 compared to vibroseis trucks or Explorer 860 and it is equally safe to use only when handled correctly by experts. It can be used in both land and marine work in most climates and field conditions. Characteristic of seismic dynamite explosive developed for seismic work use nitro-glycerine 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 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 must be moved on a regular basis. If the 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 source but once it is gone it is gone since it is not renewable, and.
- Dynamite is a 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 Explorer 860 as an Energy Source

The Explorer 860 has the capability of generating a very large surface impact, with a high degree of repeatability, but it is also controllable so that the impact effort can be reduced if required (Fig. 3.4 and Plates 3.1 and 3.2). This control has helped to minimise 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 a shot-lived limited imprint on the ground (Plate 3.2). The impact on the steel, steel on steel and energy is transferred. One disadvantage of Explorer 860 is its capital deployment to site of interest and maintenance. The Explorer 860 system uses smaller equipment, flexible lines to avoid trees and critical habitat, mulchers to manage small undergrowth and prevent root disturbance, and portable support operations to reduce the need for heavy equipment and minimise vehicle access requirements. The system was developed by Polaris, Canada's oldest and most experienced seismic company and a recognised world-leader in low-impact seismic surveys (Fig. 3.4). The Explorer 860 is an entirely new type of surface energy source. It provides unrivalled force and production using servo-valve and mass Low Vibration Track (LVT) technology to produce the most powerful, repeatable and productive surface energy source in the World.

Figure 3.4: Specifications of the Explorer 860, potential energy source for proposed 2D seismic survey operations in PEL 93 (Source: https://polarisseismic.com/services/explorer-860.html).

Plate 3.1: The Explorer 860 being used for the Phase I 2D seismic survey along Line 6 (main photo) and lines 9 and 4 top and bottom inserts respectively.

Plate 3.2: Ground footprint left by an Explorer 860 after data acquisition at each station along a given survey line.

3.3.2.3 Vibroseis Trucks Such as a Nomad 65 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 near the produced signal source (Teasdale et al., 2006 and Plate 3.3).

With enhanced mechanical and hydraulic components and shaker redesign, latest vibroseis such as the Nomad 65 with similar specs to the Explorer 360 has a superior performance of optimised broadband acquisition by bringing down the sweep start's frequency at full drive from 7 to 5.4Hz (Fig. 3.5). Therefore, the time spent in emitting the very low frequencies from 1Hz can be significantly reduced, with a positive impact on crew production and cost. New technologies in Vibrioses such as the Nomad 65 will facilitate the recording of an extra low frequency bandwidth that has proved to be very beneficial for vertical resolution and seismic inversion. Many of the vibrator's components have also evolved to provide customers with improved ergonomics.

Newly developed features include the Intelligent Power Management. This onboard software technology reduces environmental impact by performing an electronic control and regulation of the vibrator engine's RPM (Revolutions Per Minute) to match engine load, allowing for an appreciable fuel saving.

Overall, Vibroseis trucks, especially the recently designed broadband units have 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) and that is where the Explorer 860 has greater advantages.

Plate 3.3: Vibroseis used as energy sources for onshore oil and gas exploration process (Source: REN, 2021).

Nomad 65 *Neo*

Go Broadband!

// **BROADBAND PERFORMANCE**
Stronger low frequency : 5,4 Hz @ full drive

// **ENVIRONMENTALLY FRIENDLY**
Up to 15% fuel savings with IPM

// **HIGH RELIABILITY**
Proven design
More than 60 customers

Nomad 65 *Neo* is the new Sercel 62,000 lbf broadband vibrator, capable of delivering stronger low frequency content with full drive achieved from 5.4Hz. This enhanced performance is made possible using the latest innovations in shaker and hydraulic circuitry design.

Another newly developed feature is the IPM (Intelligent Power Management) option. By optimizing engine efficiency, IPM will reduce fuel consumption by up to 15%.*

* The IPM option can also be integrated into the existing Nomad 65

Specifications	
Peak force output	278 kN / 62,400 lbf
Hold Down Weight	28,294 kg / 63,610 lb
Rated frequency	1-250 Hz (full drive from 5,4Hz)
Mass/BasePlate Ratio	3.01
Operating temperatures	-50°C / + 56°C**
Full-drive start frequency @ 62,000 lbf	5.4 Hz
Length	10.64m (34 ft-11 in)
Width*	3.42 m (11 ft-3 in)
Height*	3.22 m (10 ft-7 in)
Gradeability	60 %

*According to tires type
**Specific use conditions

iPM Intelligent Power Management

VIBRATOR AUTO-GUIDANCE

Fully compatible with newly Developped Sercel Vibrator Auto Guidance

Figure 3.5: Specifications of the Nomad 65 vibroseis (Source: REN, 2021).

3.3.2.4 Energy Source for the Proposed 2D Seismic Survey

The Proponent has not yet issued a contract for the third-party services provider who will be undertaking the proposed 2D seismic survey. The choice on the use of either the Explorer 860 or vibroseis such as the Nomad 65 will largely depend on the availability, costs, and environmental considerations. The proposed 2D seismic survey operations will leverage on the monitoring results, experiences gained and lessons learned during the acquisition of the previous 2D seismic survey operations in different parts of Namibia. The following are the key characteristics that favours the use of the Explorer 860 as an energy source for the proposed 2D seismic survey operations (Fig. 3.4):

- The Explorer 860 is the world's 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 trucks.
- Has very high fold.
- Has better quality than dynamite.
- Is perfect for high density population and environmental sensitive areas, and.
- Has only single unit required per second source point.

The following are the key characteristics that favours the use of the vibroseis such as the Nomad 65 as an energy source for the proposed 2D seismic survey operations (Fig. 3.4):

- 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, and.
- Vibrational sources distribute their power for a sustained period usually several seconds.

3.3.3 Proposed 2D Seismic Implementation Stages

The implementation of the proposed 2D ground survey programme can be divided into six (6) stages to be assessed during the EIA stage. The following is the summary of the six (6) stages:

1. Planning and mobilisation (Pre-survey preparation, field scouting and mapping of buffers and offsets along proposed survey lines).
2. Base camp and fly-camp sites setups and operations.
3. Widening of tracks by pruning vegetation overgrowth and tracks levelling as may be applicable.

4. Actual survey operation (data acquisition), and.

5. Demobilisation and closure (Survey completion).

3.3.4 Pre-Survey and Survey Operations

The data acquisition process for the proposed 2D seismic survey operations will be undertaken as illustrated in Fig. 3.2. Table 3.1 shows the parameters design options for the proposed 2D seismic survey in PEL 93. Key specifications of the Explorer 860 to be used as the energy source for proposed 2D seismic survey operations are shown in Fig. 3.4. The Survey Team will mobilise and will consist of one (1) Survey Coordinator, one (1) Survey Processor/Mapper, two (2) National field mappers and six (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 the area (Plate 3.4). 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 trees. 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 the database. Co-ordinates will be based on the geodetic framework as specified by MEL. 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 MEL 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 MEL 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 MEL 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.

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 MEL for approval prior to start-up.

Plate 3.4: Example of a forward survey team installing receivers during the Phase I 2D seismic survey operation for REN in 2021.

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 the energy source as illustrated in Fig. 3.1.

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 for the proposed survey (Plate 3.5).

The following is the summary of the key receiver types considered to be used for the proposed 2D survey operations (Plate 3.5):

(i) Smart Solo: According to Smartsolo (https://smartsolo.com), the wireless receivers from smartsolo is designed for high-quality seismic data is derived from high-quality seismic sensors. It is a high-sensitivity geophone that is specially designed for single point receiver applications.

It is well known to the seismic industry as the top-quality high-sensitivity geophone and is widely used by major contractors and equipment manufacturers with the following characteristics (https://smartsolo.com and Plate 3.5): High quality, high sensitivity, low distortion, super reliable, greater savings, single point receiver, available in 10 Hz and 5 Hz, and high spurious frequency.

(ii) Quantum: The Quantum recording system is based on a wireless platform without radio infrastructure. Deployed worldwide in a variety of challenging environments, it has proved its ability to reduce footprint and improve operational efficiencies (www.inovageo.com and Plate 3.5). Quantum's single-point sensor node offers a large surface area and a strong geophone spike and can be buried to improve coupling and reduce environmental noise. Supporting external geophone strings and marsh phones allows you to seamlessly integrate to a project where infrastructure or the environment can be challenging.

The Quantum is handled in a single user-friendly interface through INOVA's iX1 control system. The iX1 is the command-and-control intelligence platform included in every INOVA seismic acquisition system, and.

(iii) Nu-Seis: The Nu-Seis receivers are self-contained seismic nodal recording units with a 58-gram internal electronic cab (eCab) that can be quickly removed and inserted into a dozen different interchangeable NuSeis formfactors, each optimally suited for environments to provide peak operating performance, and the highest quality ground coupling.

The unit has a strong and durable two-piece, water proof Lexan external assembly, with locking rings that enclose the internal battery and geophone. All the NuSeis transformer formfactors have the same upper Lexan dome with four stainless steel MIM protrusions for data download and power recharge (www.steel-technology.com).

The following are key characteristics of the Nu-Seis receivers (www.steel-technology.com and Plate 3.5): All in one device – geophone, electronics, and battery, formfactor options for all environments, raw Differential Global Positioning System (DGPS) data recording enables DGPS post processing of node location, high Speed Universal Serial Bus (USB) data download, EarthGrip ground coupling providing superior data quality and highly visible light emitting diodes (LED) status indicators.

Plate 3.5: Example of the latest types of wireless recording instrumentation technology that may be used for the proposed 2D seismic survey.

3.3.6 Survey Setback Distances / Exclusion Zones (Buffers)

Namibia does not have specific regulations or guidelines on setback distances from specified infrastructures or sensitive environment with respect to onshore seismic survey operations. As international operator, MEL could adopt the Alberta Government of Canada Distance Requirements Exploration Directive 2006-15 as shown in Table 3.1 as well as additional guideline as provided by the International Association of Geophysical Contractors (IAGC) that have been used by other operators in Namibia.

The setback distance guidelines as shown in Table 3.1 could be used for the proposed 2D seismic survey with respect to the non-explosive column guidance because the Proponent is going to use either the Explorer 860 or Vibriosis as the energy source.

Table 3.1: Example of the setback distances to specified structures that may be used for the proposed 2D seismic survey operations (Source: Distance Requirements Exploration Directive 2006-15, Alberta Government, Canada).

Table of Required Setback Distances to Specified Structures	Explosive		Non-Explosive
Specified Structure	**Charge Size**	**Distance**	**Distance**
Residence, barn, or any building(s) with a concrete base, concrete irrigation structures (e.g., drop structures, head works); concrete lined irrigation canals, and concrete water pipelines.	Up to and including 12 kg	180 m	50 m
	> 12 kg < = 20	200 m	
Water wells, developed spring, observation well, or piezometer.	Up to and including 12 kg	180 m	100 m
	> 12 kg < = 20	200 m	
High Pressure Pipelines High pressure pipelines are pipelines that operate at, or are intended to operate at a pressure in excess of 700 kilo pascals or less. **Note:** All distances are measured from the centre of the pipeline.	< = 2 kg	32 m	15 m
	> 2 & < 4 kg	45 m	
	> = 4 & < 6 kg	55m	
	> = 6 & < 8 kg	64 m	
	> = 8 kg & < 10 kg	70 m	
	> = 10 & < 12 kg	78 m	
	> = 12 kg < = 20 kg	100 m	
Low Pressure Pipelines Low pressure pipelines are pipelines that operate at, or are intended to operate at a pressure of 700 kilo pascals or less. **Note:** All distances are measured from the centre of the pipeline.	Up to and including 20 kg	3 m	3 m
Dugouts Measured from the inside edge of high water mark.		50 m	25 m
Irrigation Canal (other than concrete lined) Irrigation canals that are more than 4 m wide.		10 m	10 m
Buried Water Pipelines (other than concrete lined)		3 m	3 m
Dams Dam means a barrier constructed and having a storage reservoir capacity of at least 30,000 m^3, and which is at least 2.5 m in height when measured vertically to the top of the barrier.		180 m	50 m
Cemetery Distance to the energy source is measured to the surveyed boundary of the cemetery.		100 m	50 m
Buried Lines and Survey Monuments Telephone lines and telecommunications lines.		2 m	2 m
Domestic Septic Tank or Mound A septic tank is defined as a tank that is used as septic storage device. A mound is a septic storage device that is located above ground surface.		15 m	15 m

Table of Reduced Setback Distance to Specified Structures with Written Consent of the Owner of the Structures	Explosive		Non-Explosive
Specified Structure	**Charge Size**	**Distance**	**Distance**
Residence, barn, or any building(s) with a concrete base, concrete irrigation structure (e.g., drop structures, head works), concrete-lined irrigation canals, and concrete water pipelines. Water wells, developed springs, observation wells, or piezometer.	< = 2 kg	64 m	50 m
	> 2 & 4 kg	90 m	
	> = 4 & < 6 kg	110 m	
	> = 6 & < 8 kg	128 m	
	> = 8 & < 10 kg	142 m	
	> = 10 & 12 kg	156 m	

3.3.7 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. Field Processing will be completed daily with the requested processing flows outlined in the Scope of Work. All supporting equipment and services will be available including plotters, monitors, etc. Very-small-aperture terminal (VSAT) communications will allow transmission of data to processing centres as required by MEL.

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 acquired.

A team of geophysicists or geologists will interpret the processed data. The collected seismic data will be interpreted and it is important to know that 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.

3.4 Logistics and Resources

3.4.1 Overview

The proposed 2D seismic survey will likely be completed within 3 to 4 months from the date of implementation. The exploration team will comprise several specialists such geophysicist, geologists, surveyors, engineers as well as other supporting crew members such as Community Liaison Officers (CLOs), exploration camp management, drivers, vehicles maintenance as well as catering teams. It is estimated that a total of up to forty (40) persons and more than thirty (30) vehicles will be hired locally with owners / drivers.

3.4.2 Base Campsite/s

The base camp for the proposed 2D seismic survey operations will be set-up at one or two of the lodges within the general area of Oshivelo. The base camp shall offer budget to luxury accommodation, as well as a restaurant, a swimming pool, conference and or meeting facilities, and campsite area as well as other operational requirements.

3.4.3 Fly-Camps

Temporary fly-camps lasting between 1-2 weeks will be created within each survey block area. In consultation with the local communities and land owners, temporary fly-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 tented footprints. The following are some of the key consideration that shall be considered when selecting camp site areas:

- When working in communal areas, land access and creation of a fly-camp site shall be undertaken with the permission of the traditional authority and the local headperson and owner of the land.

- When working in freehold commercial farmland, land access and creation of a fly-camp site shall be undertaken with the permission of the private land owner.

- ❖ The fly-camps 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 be cut around the selected fly-camp sites.

- ❖ The fly-camp sites shall be selected in abandoned and previously cleared fields in order not to disturb pristine areas, and.

- ❖ The camp site shall be equipped with all the facilities and services including water supply, solid waste management bags and chemical toilets.

The fly-camp will generally house the Explorer 860 or Vibroseis crew driver's mechanics and senior recording crew and the field medic. Kitchen and Mess will be setup in each camp and breakfasts and dinners will be provided. Water and perishable food supplies will be delivered each day to the fly-camp. Generated waste will be taken and disposed of at the Oshivelo Waste Disposal site.

Packed lunches will be provided by the outside caterer and delivered each day to the crews in the field. Ablutions will comprise one chemical toilet per fly-camp and two shower locations with offset from the camp by 20 metres. Solar shower bags filled every day and left in the sun to heat the water up will be used. Fly-camp teams will be swapped every few days and brought back to base camp for a rest and proper night sleep in a bed and to get their laundry done.

3.4.4 Lines Widening / Clearing / New Cutlines

The proposed survey will be undertaken along the already existing roads, farm fences and tracks and already disturbed areas. In consultations and with the approval of the land owners / local community, very limited new cutlines may be created to either straighten a survey line or create new access as may be required. 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 MEL's guidelines for offsetting source points, priority will be to minimise bush cutting and offset points to clear locations.

However, if requested by the local community / stakeholders or land owner 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) operations. No big trees shall be cut unnecessarily during the widening of existing access or creation of the new access as may be required. The following is the summary of the methods that may be used in the improvement of the access and creation of the new access as may be required:

- ❖ Mechanically cutline would be with a Mulcher and will avoid the larger trees.

- ❖ The existing roads, tracks and fence line would have likely been cleared in the past but would need improvement as may be required.

- ❖ The method of line cutting to be done on private land would be negotiated with the owner, but would first try for mechanically cutline. However, precedent would be given to the owner and his / her ability to provide a labour force for pruning his own land.

- ❖ Rangeland would be cleared with local labour if needed.

- ❖ A 3m wide panga cutting will be undertaken where local labour exists.

- ❖ Some of the lines are in remote areas, it would be difficult to assemble a local labour force for cutting, and.

- ❖ Most of the existing tracks in the communal areas would need a pass with a loader to ensure the ground conditions is optimal for the thumper to produce the best quality record.

3.5 Vibrations, Noise and Dust

3.5.1 Vibrations and Noise

The characteristics of vibrations and noise vary substantially among sources. Each source type exhibits variance in amplitude (i.e., loudness), frequency profile (i.e., pitch), and spatial and temporal patterns. Onshore seismic survey operations can also be affected by existing local vibrations and noise from vehicles, minor ground vibrations such as cutting of trees or even wind moving vegetation.

The interaction of these characteristics is what determines in a narrow sense the impact of noise on the receiving environment such as humans and wildlife. One concern of interest during the proposed 2D seismic survey operations is the interference of frequencies by the seismic activities with that of local wildlife including elephants as well as the impact of vibrations on the existing structures such as houses, water wells and other cultural resources and sites. Interference is defined as the effect produced when two waves of the same frequency, amplitude and wavelength travelling in the same direction in a medium are superposed (i.e as they simultaneously pass-through a given point). When the crest of two waves of equal wavelength is together, the waves are said to be in phase, that is, they have a phase difference of zero. In this case, according to the principle of linear superposition, the waves will reinforce each other, or add up and will undergo constructive interference and thus affect local wildlife vocalisation of the same frequency if present in area being surveyed.

On the other hand, if two waves superimpose with each other in opposite phase, the amplitude of the resultant is equal to the difference in amplitude of individual waves, resulting in the minimum intensity of the wave. This is known as destructive interference and thus will produce a negligible effect on the local wildlife vocalisation of the same frequency if present in the area being surveyed.

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.

It is very important to note that the waves generated by a 2D seismic survey are different from earthquake created seismic waves. Earthquake generated seismic waves have periods, and wavelengths that are in minutes and kilometres, respectively, while the 2D seismic survey operations produces waves with periods, and wavelengths of tenths of a second and tens of meters respectively. Therefore, the level of ground displacement associated with the type of waves generated by an onshore seismic survey operation compared to an earthquake event, differs considerably. Earthquake ground displacement are in meters and can result in weak buildings collapsing while the millimetre / few centimetres onshore seismic survey operations ground displacement will generally have negligible effect on the buildings.

3.5.2 Dust and Local Air Quality Influences

The following are possible sources of temporary localised air pollution will be evaluated during the EIA stage with mitigation measures provided in the EMP Report:

(i) Sources air quality influences;

- ❖ Increased vehicle activities during survey operations along the gravel and tracks, and.
- ❖ Isolate and remote temporary fly-campsites 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 and subprojects. Detailed information on the sustainability, health, safety, environment, and social governance of the Proponent can be found at www.monitorexploration.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-safety 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, other stakeholders and global expectations. The Environmental, Social and Governance (ESG) criteria of the Proponent provides a basis for measuring key indicators performances against the global standards that have been committed to; in particular, information on the project activities, in relation to measurable standards.

3.6.4 Community Relations and Social Responsibility

MEL is committed to working with all the local communities within the project area. The company will appoint local community members to work as Community Liaison Officers (CLOs) in creating a sustainable socioeconomic bridge between the various local communities and the project teams at various corporate levels. The Proponent is committed to meaningful and positive impacts on the lives of the residents by identifying key priority areas that are important to the needs of the local communities especially the fight in reducing inherited generational poverty in communal areas.

3.6.5 2D seismic survey Contractors Operational Manuals and Policies

The Contractor that 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 MEL. 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, HSE Management Manual, Community Relations 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:

- Petroleum (Exploration and Production) Act, 1991 (Act 2 of 1991).
- Petroleum Laws Amendment Act, 1998 (Act 24 of 1998).
- Petroleum Taxation Act, 1991 (Act 3 of 1991).
- Model Petroleum Agreement (MPA), 2007.

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, and.

(iii) Petroleum Production Licence (PPL): A production licence allows its holder to exclusively carry-out 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.

MEL is holding a PEL granted under Section 29-38 of Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991).

The Petroleum Laws Amendment Act, 1998 (Act 24 of 1998) provides for the amendments to the Petroleum (Exploration and Production) Act, 1991, (Act No. 2 of 1991), so as to make provision for the

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 Petroleum Exploration License Application Process in Namibia

In the absence of an auctioning licensing regime process, any individual or entity can apply for a Petroleum 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 must 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 the chance of the application being granted once submitted to the Government.

Following on 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 Government (Ministry of Mines and Energy) has formally accepted the application. The MPA is usually reviewed by technical, financial, and legal teams from both the applicant and the Government of Namibia sides prior to the negotiation of the terms and conditions of the Petroleum Agreement (PA).

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 phases 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 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 is granted such a license.

Once the Petroleum Agreement has been agreed, signed and the annually recurring license fees paid, a Petroleum Exploration License may be 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).

The license fees payable ranges between N$60.00 – 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). 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 over a specific licensed area 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 the holder of a PEL, rights 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 twelve (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 (2) 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 twenty-five (25) years and may be renewed for such further period, not exceeding ten (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 a 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 MEL 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.

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-

Access cutting.

Clearing and timber salvage.

Wildlife and habitat protection.

Resource protection.

Fuel storage and handling.

Use of explosives.

Camps and staging areas.

Liquid and solid waste disposal.

Cultural and archaeological sites.

Selection of drilling sites.

Terrain stabilisation.

Protection of freshwater horizons.

Blowout prevention plan.

Combating oil spills.

Flaring during completion and testing of gas and oil wells.

Well abandonment.

Rig dismantling and site completion.

Reclamation for abandonment, and

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 Forest, 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 Forest.

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.

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 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.

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. EIA and EMP regulatory compliance studies have been undertaken for seismic survey operations and an Environmental Clearance Certificate (ECC) was granted by the Environmental Commissioner in the Ministry of Environment, Forestry and Tourism (MEFT) on the 2nd July 2021 (Figs. 1.4 and 1.5). A detailed outline of the MEFT defined operational restrictive area attached to the copy of the Environmental Clearance Certificate (ECC) granted for the 2D seismic survey operations in PEL 93 is shown in Fig. 1.5.

MEL is proposing to undertake the 2D seismic survey operations within the framework of the already granted ECC and in line with all the national regulatory provisions. The Petroleum Agreement allows the operator to proceeded with subsequent similar exploration activities if the operator 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 the current Exploration Licence.

4.3.2 Communal Land Rights, Consents and Access Agreements

The proposed 2D seismic survey operations and the AOI in PEL No. 93 falls within the communal land of Oshikoto and Ohangwena 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 a part thereof can only be given as customary land right or right of leasehold 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) provides for the allocation of rights in respect of communal land, establishment of Communal Land Boards, gives powers to the Chiefs and

Traditional Authorities and the regional Land boards in relation to communal land matters and provides for incidental matters related to the allocation and administration of Communal land in Namibia. Although communal land is owned by the State, allocation of surface user rights is delegated to the traditional authorities. Consents and access to surface land rights for the proposed 2D seismic survey operations shall be channelled through the specific lease holder/s if the land has been formally allocated to an individual or family with supporting documentations such as a leasehold. In the absence of a formal leasehold, access for surface user land rights shall be challenged first through the local village headman / headwoman in order to confirm the local land ownership situation before concluding any access agreement and compensation thereof as may be applicable. Appropriate written consents / access agreement shall be obtained as may be applicable before the implementation of the proposed 2D seismic survey activities in any local community.

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" 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.

4.3.4 Atmospheric Pollution Prevention Legislation

The Atmospheric Pollution Prevention Ordinance, 11 of 1976 falling under the Ministry of Health and Social Services (MoHSS) 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

The Labour Act, 1992, Act No. 6 of 1992 as amended in the Labour Act, 2007 (Act No. 11 of 2007), falling under the Ministry of Labour, Industrial Relations, and Employment Creation (MLIREC) refers to severance allowances for employees on termination of a contract of employment in certain circumstances and health, safety, and welfare of employees. 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 use 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 only the 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:

- Namibian Constitution Articles 91(c) and 95.
- Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991).
- Environmental Management Act (No. 7 of 2007) and Regulations (2012).
- Water Act, 1956, Act No. 54 of 1956.
- Hazardous Substances Ordinance (1974).
- 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).
- Forest Act (No. 12 of 2001) and Forest Amendment Act (No. 13 of 2005).
- The Labour Act, 1992, Act No. 6 of 1992 as amended in the Labour Act, 2007 (Act No. 11 of 2007).
- Labour Act (No. 11 of 2004) – Health & Safety Regulations (1997).
- 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 National Regulatory Agencies, Permits and International Treaties

4.4.1 National 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.

AUTHORITY	TYPE OF AUTHORISATION
Office of the Environmental Commissioner (OEC), Ministry of Environment, Forestry and Tourism	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
Ministry of Mines and Energy (MME)	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.
Ministry of Agriculture, Water and Land Reform	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 Forest (DOF) is responsible for issuing of forest permits with respect to harvest, transport, and export or market forest resources.
Oshikoto and Ohangwena Regional Councils	Overall responsibility of management of regional land resources and communal land surface user rights through the Communal Land Boards as may be required by the proposed project.
Oshikoto and Ohangwena Regions Traditional Authorities	Traditional authorities in Namibia are the custodians of State land falling within authority of the respective tribal land. With the approval of the Regional Land Boards, traditional authorities through the local structures of headmen and headwomen as well as Village Development Communities (VDCs) are responsible for allocation of communal land surface user rights to the local communities.

Table 4.2: Summary of the permit register.

ACTIVITY	APPLICABLE LEGISLATION	PERMITTING AUTHORITY	ASSESSMENT RESULTS
Petroleum Exploration License (PEL)	Petroleum (Exploration and Production) Act 1991 (Act 2 of 1991) As Amended	Ministry of Mines and Energy (MME)	Issued by MME
Environmental Clearance Certificate (ECC) for Seismic Survey	Environmental Management Act (2007) and the Environmental Impact Assessment Regulations, 2012	Ministry of Environment, Forestry and Tourism (MEFT)	ECC Granted on the 2nd July 2021 and Valid for three (3) years. Phase II Survey requires Consent
Land rights covering the proposed project location	Regional and Local Authorities Act, 1992, (Act 23 of 1992) as Amended, Communal Land Act (No. 10 of 2002), Communal Land Reform Amendment Act (No. 13 of 2013).	Oshikoto Regional Council, Traditional Authority and Private Commercial and Communal Land Owners	Proposed exploration does not require any Lease Agreement. Access Agreements and Consents shall always be concluded as applicable
Abstraction of water	Water Resources Management Act, 2004 (No. 284 of 2004).	Ministry of Agriculture, Water and Land Reform (MAWLR)	Freshwater Abstraction and Waste Water Discharge Permits not Required. The proponent will utilise a temporary well-equipped campsite
Discharge of effluents or construction of effluent facility			
Removal, disturbances, or destruction of bird eggs	Nature Conservation Ordinance 4, 1975.	Ministry of Environment, Forestry and Tourism (MEFT)	No removals of protected species or mature trees anticipated. The creation of new cutlines subject to the approval of the land owners shall be supervised MEL Team in line with the provisions of the Forest Act, 12 of 2001
Removal, disturbance of protected plants.			
Removal, destruction of indigenous trees, bushes, or plants within 100 yards of stream or watercourse.	Forest Act, 12 of 2001.		

4.4.2 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 and Conference of the Parties (COP), 26, commitments.
- Convention on Biological Diversity, 1992.
- Vienna Convention for the Protection of the Ozone Layer, 1985.
- Montreal Protocol on Substances that Deplete the Ozone Layer, 1987.
- United Nations Framework Convention on Climate Change, 1992.
- Kyoto Protocol on the Framework Convention on Climate Change, 1998.
- Basel Convention on the Control of Transboundary Movement of Hazardous Wastes and Their Disposal, 1989.
- World Heritage Convention, 1972.
- Convention to Combat Desertification, 1994. and
- Stockholm Convention of Persistent Organic Pollutants, 2001, and.
- Southern Africa Development Community (SADC) Protocol on Energy.

4.5 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 ECC to be granted for the proposed seismic survey operation in PEL 93 as well as all other 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 at all times with continuous engagements with the traditional authorities, local communities, 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 most parts of the year. Summer temperatures on average range between a minimum temperature of 20°C to maximum day temperatures of 30-35°C for the 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.

Rainfall decreases generally from east to west, 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 patterns in the region vary considerably and drought cycles are also common. The mean annual rainfall ranges from 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).

5.2 Regional Physical Geography and Land Use

The landscape of PEL No. 93 covering Oshikoto and Ohangwena Regions and according to Agro-Ecological zones of the country are Kalahari Sand plateau with deep sands on the northern area and Kalkveld on the southern and western area (Tsumeb and Etosha). There are two major drainage systems in northern Namibia namely Cuvelai at the north west stretched from Angola to Etosha pan and the Omuramba which is stretched from Otavi highlands and drainage to Etosha pan (Namibia Population and Housing Census, 2011). The license area is drained by the Omuthiya and Omuramba Owambo Ephemeral River Channels that flows into the Etosha Pan.

The land use in the general area is mainly large to small-scale communal / subsistence farming comprising cattle, goats, seasonal crop farming, particularly to the north of the region. To the south of the proposed survey area much of the land is used for agriculture, conservation, and tourism freehold land, with resettlements, and government or parastatal (Figs. 5.2-5.5). Freehold (commercial) conservation and tourism related land uses such as the Onguma Game Reserve are common around the commercial farms found to the southwest and southern parts of the proposed survey area (Fig. 5.5). Commercial cattle and small stock agriculture with irrigated crop farming operations are among the key activities undertaken in both freehold and communal commercial farmlands. Bush thickening or encroachment is viewed as an economic problem in the general area.

No communal conservancies occur within the proposed survey area with the closest being the King Nehale Conservancy located to the northwest bordering the Etosha National Park with the major wildlife resource listed as gemsbok, springbok, kudu, blue wildebeest and giraffe (NACSO 2009, 2011). The closest Government protected area is the Etosha National Park. The Onguma Game Reserve is the closest freehold (commercial) conservation area consisting of farms bordering the Etosha National Park southwest of Oshivelo. The villages in communal areas are centred around communal water points or near schools or rural clinics (Figs. (Figs. 5.2-5.5). The following is the summary of some of the common general threats to the natural environment and habitats of the general project area especially in communal farmland:

(i) Accelerated allocation of communal leaseholds resulting in extensive fencing and forestry clearing in some places.

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

(iii) Wildfires and overgrazing due to increased number of animals.

Plate 5.1: Climatic patterns and typical afternoon to early evening heavy rainfalls with occasional thunderstorms in Oshikoto Region. The main rainy season period is 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 (see insert photo).

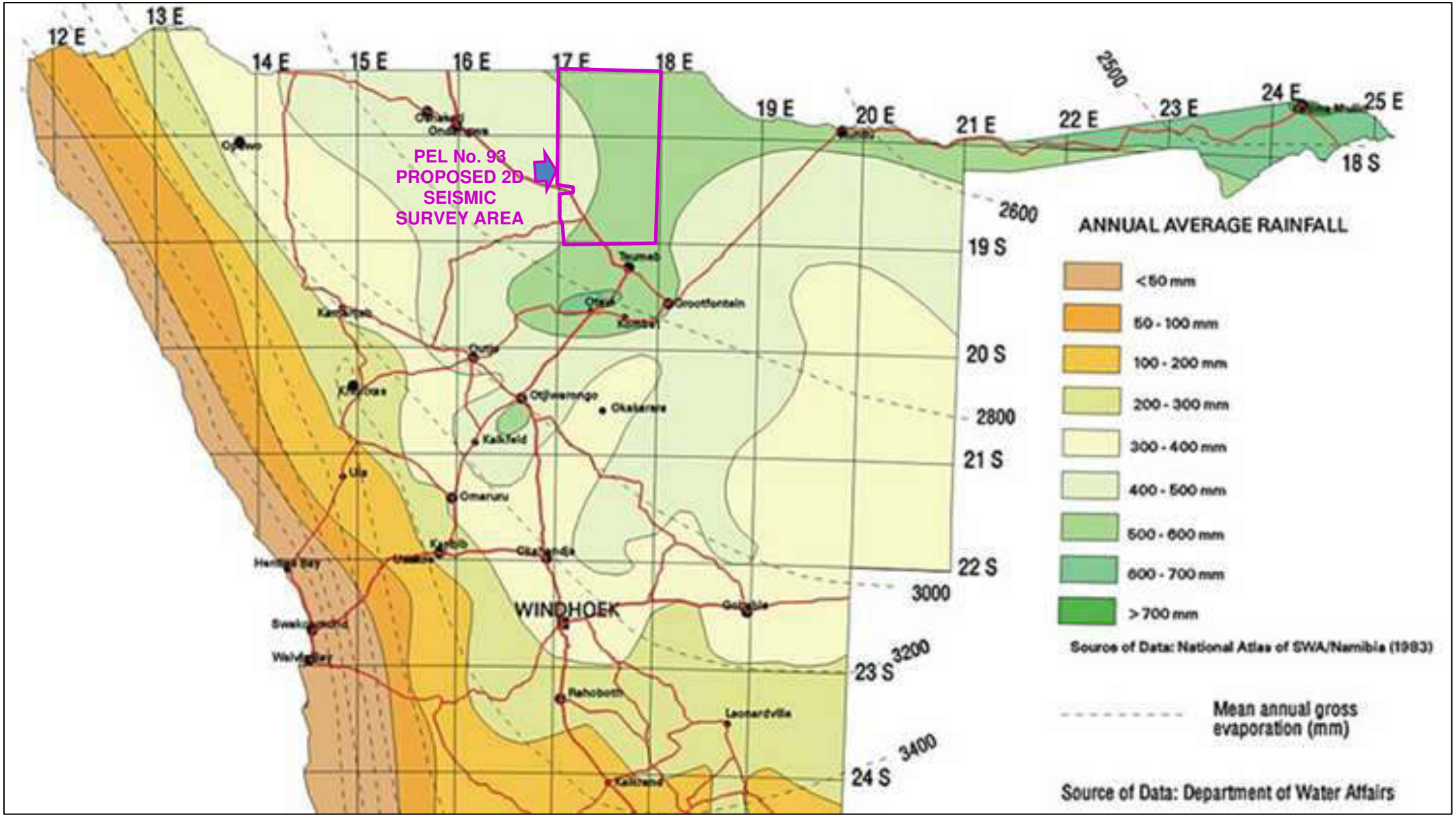


Figure 5.1: Climatic patterns of Namibia showing the location of the proposed 2D seismic survey operations in Oshikoto and Ohangwena Regions.

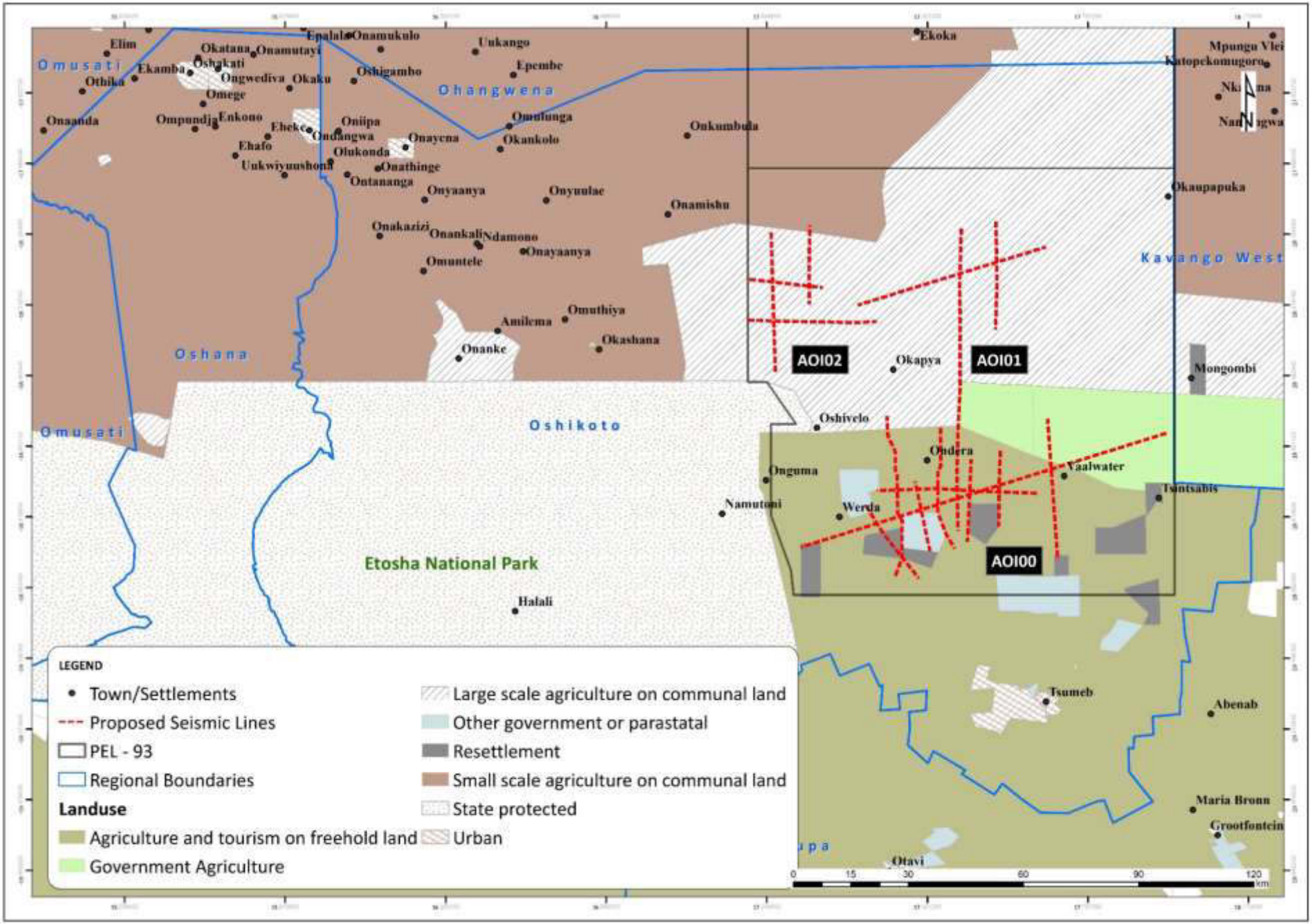


Figure 5.2: Detailed location of the key exploration Areas of Interest (AOI) and proposed 2D seismic survey lines with respect to the various land uses and other infrastructures.

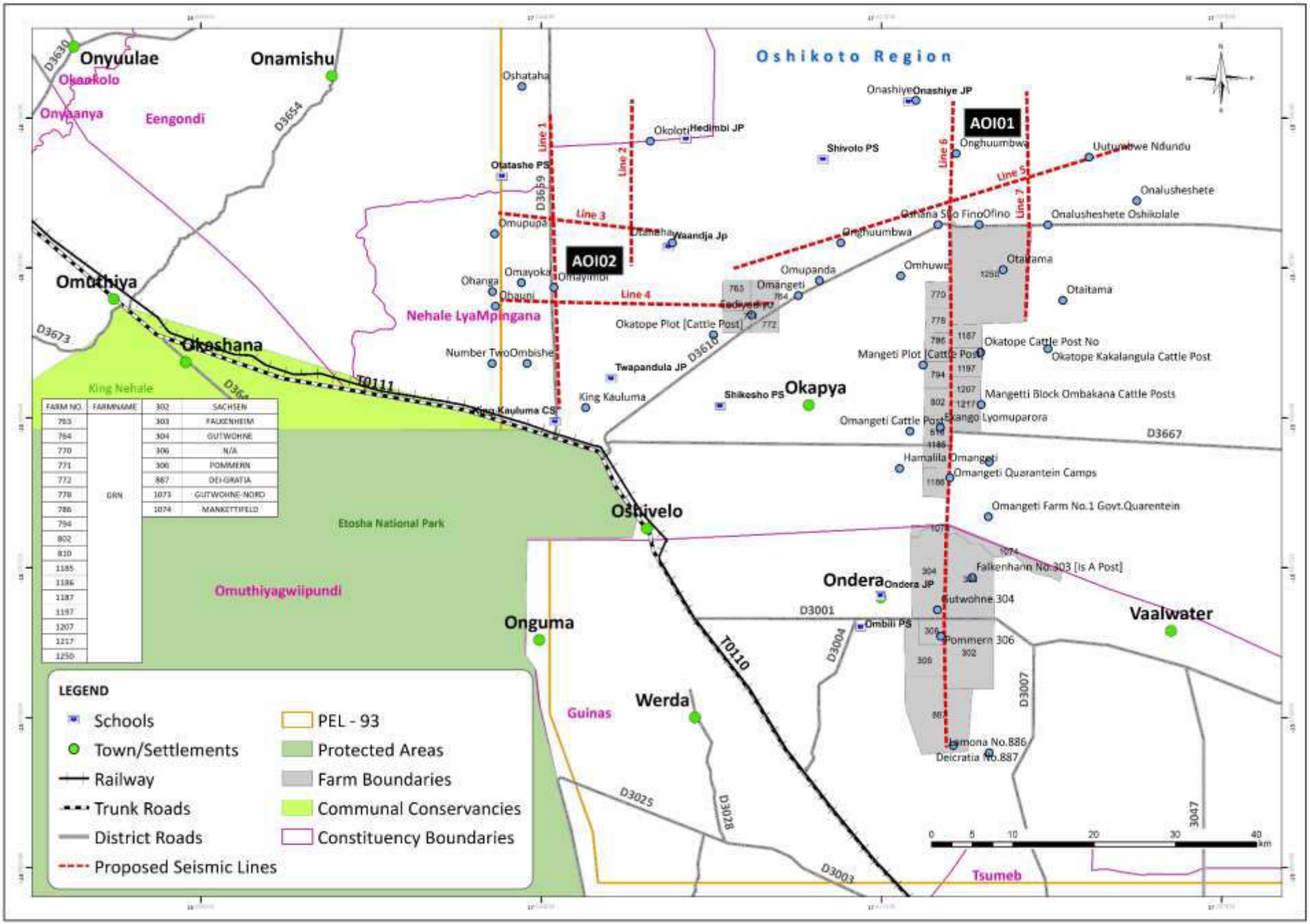


Figure 5.3: Zoomed in location of the Areas of Interest (AOI) 01 and 02 and proposed 2D seismic survey lines with respect to the various regional and settlements, schools, and farms.

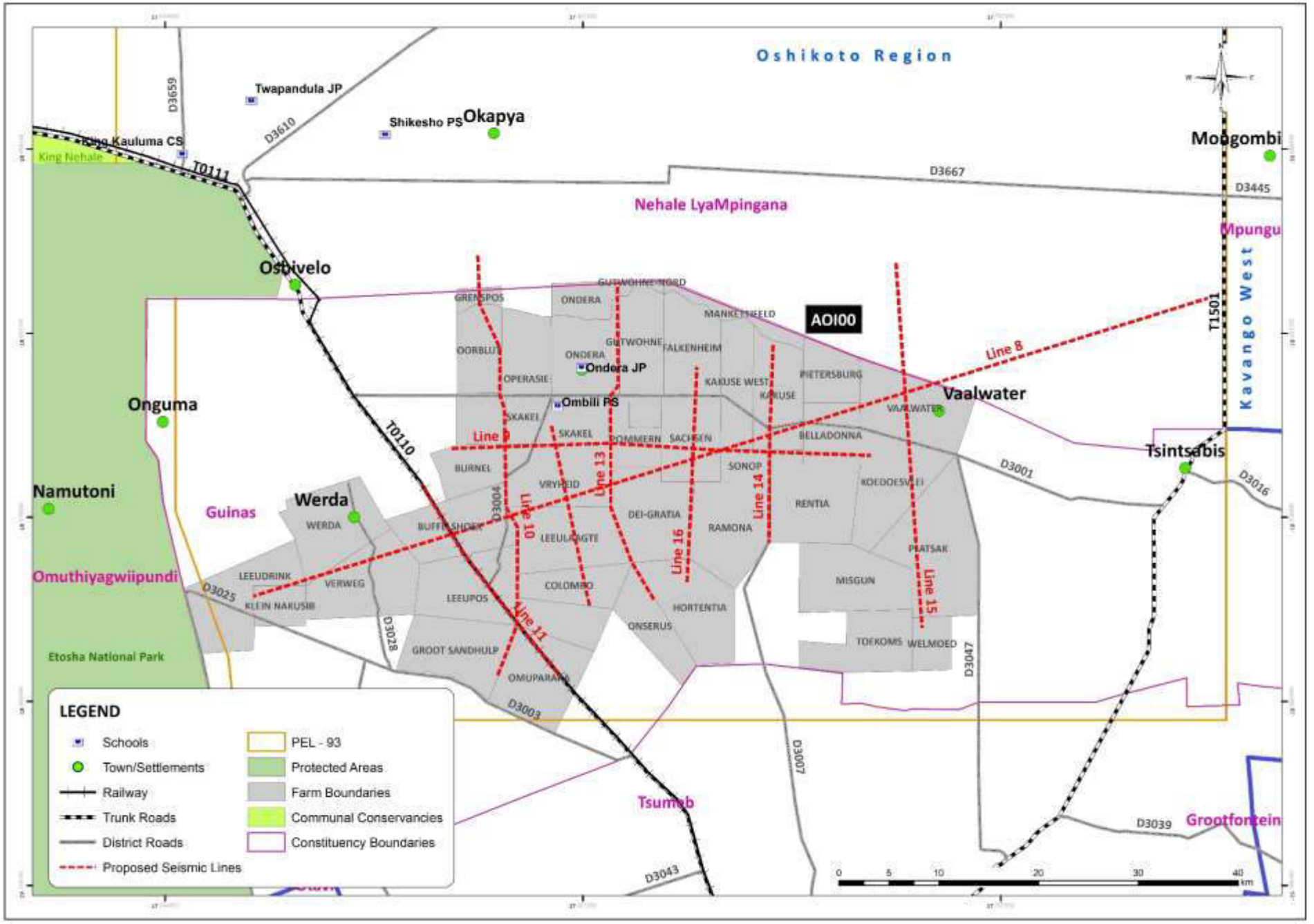


Figure 5.4: Zoomed in location of the Areas of Interest (AOI) – **AOI00** and proposed 2D seismic survey lines with respect to the various regional and settlements, schools, and farms.

5.3 Proposed Survey Area Flora, Fauna, and Habitats

5.3.1 Desktop Studies

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 Oshikoto Region – AOI00; AOI01 and AOI02 [Blocks 1717 and 1817; PEL 93] – was conducted during February 2022. This was followed up by fieldwork conducted between 4-7 March 2022 (current study) to determine the effect that the proposed ground seismic survey, using surface weight drop with Explorer 860 truck as source unit or Vibroseis with a Nomad 65 Vibrator, may have on the bio-physical environment (vertebrate fauna and flora) within the development area and immediate surroundings (especially along the general proposed seismic survey line areas).

5.3.2 Approach and Method of the Field Survey

A rapid fieldwork assessment was conducted between 4 and 7 March 2022 to determine the actual faunal and flora diversity of the project area using the following approach and methods (Annex 2):

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: Assessing 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., and.

Flora: 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 Flora and Fauna Regional Settings

PEL No. 93 and the AOI 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) (Figs. 5.5 and 5.6). The vegetation structure is classified as broadleaved woodlands (Figs. 5.5 and 5.6 and Mendelsohn et al. 2002).

It is estimated that at least 65 species of reptile, 17 amphibian, 97 mammal and 250 bird species (breeding residents) are known to or expected to occur in the general area (Annex 2). It is estimated that at least 95 species of larger trees and shrubs (>1m in height) and up to 116 species of grasses are known to or expected to occur in the general area, none of which are viewed as endemic species (Annex 2).

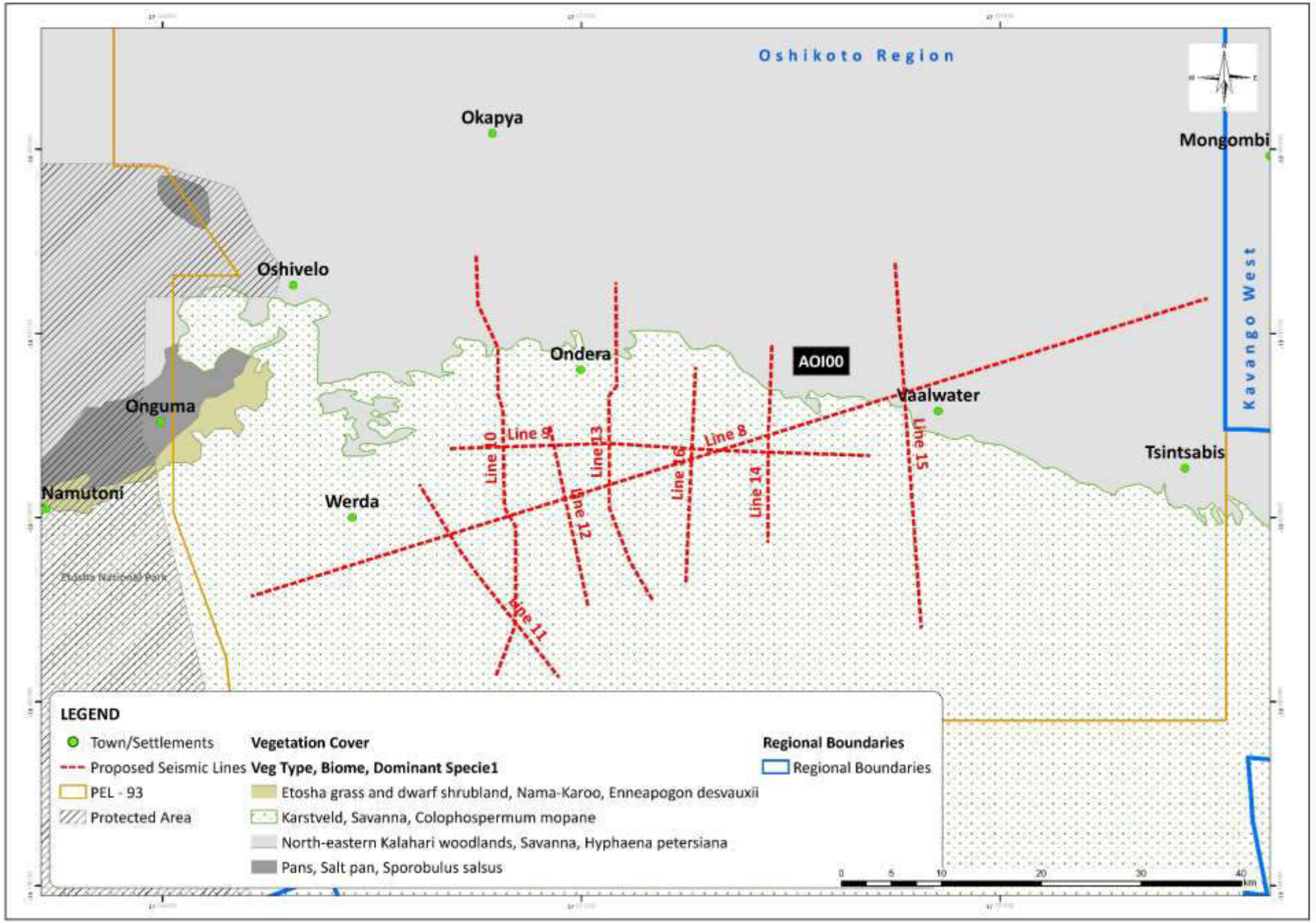


Figure 5.5: Vegetation characteristics around the AOI00 within PEL No. 93, southeast of Oshivelo.

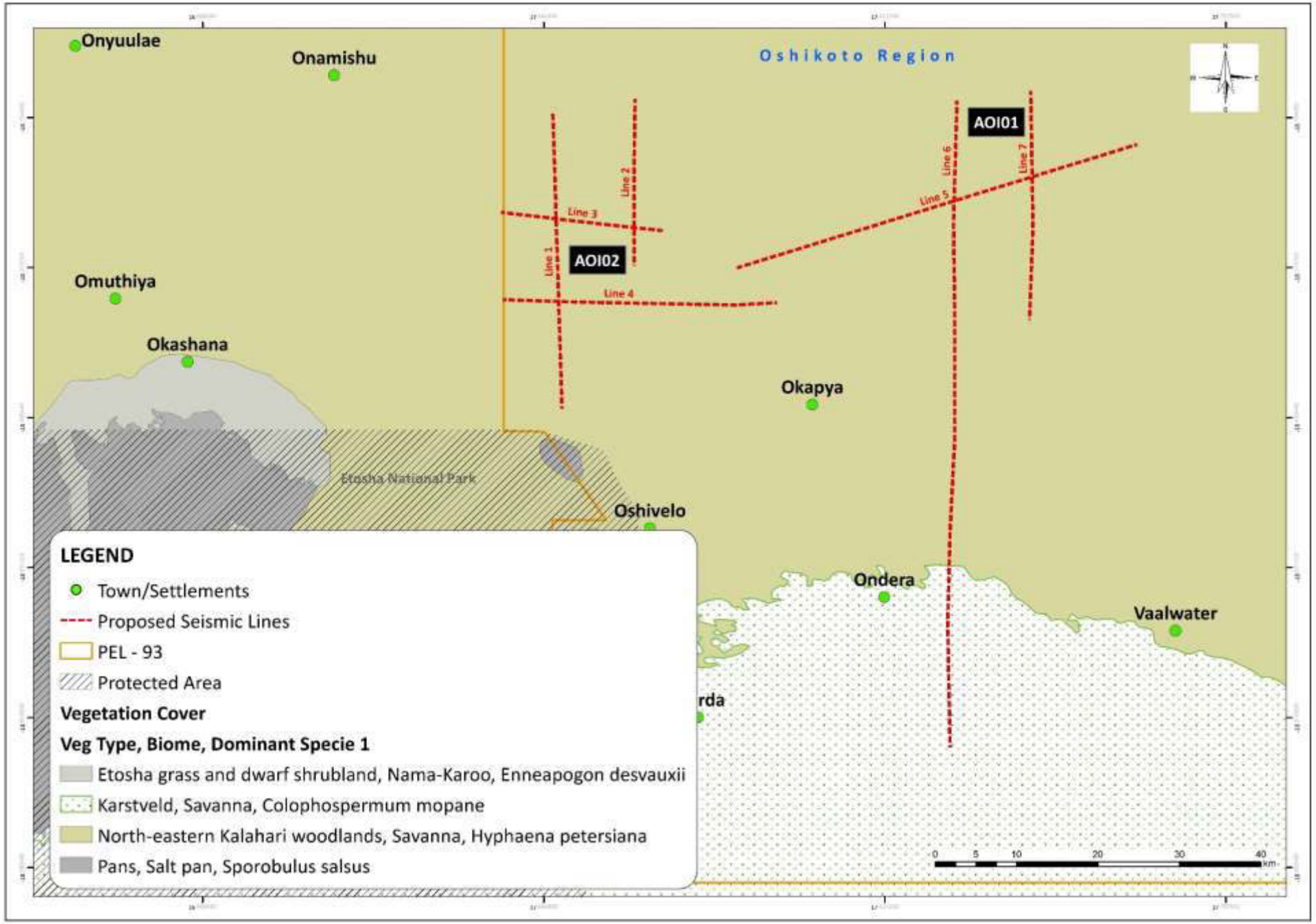


Figure 5.6: Vegetation characteristics around the AOI01 and AOI02 within PEL No. 93, north of Oshivelo.

5.3.4 Local Fauna Diversity

5.3.4.1 Reptiles

The overall reptile diversity and endemism in the general area is estimated at between 61-80 species and 5-8 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 21-30 and 41-50 for indigenous lizards and snakes, respectively. The closest Government protected area – Etosha National Park – has an estimated 109 species of reptiles (Griffin 1998a).

At least 65 species of reptiles are expected to occur in the general area with 9 species being endemic (i.e. 13.9% endemic). Two species are viewed as rare (*Gonionotophis (Mehelya) vernayi*, *Sepsina angolensis*); 4 species as vulnerable (*Stigmochelys pardalis*, *Psammobates oculiferus*, *Python natalensis*, *Varanus albigularis*); 4 species as protected game (*Stigmochelys pardalis*, *Psammobates oculiferus*, *Python natalensis*, *Varanus albigularis*); 1 species as insufficiently known (*Gonionotophis (Mehelya) vernayi*) 1 species as indeterminate (*Sepsina angolensis*) and 3 species as peripheral. All the other species are classified as "secure". Twenty species have some form of international conservation status – i.e. IUCN (2021) lists 17 species as least (all other species have not yet been assessed by the IUCN Red List); SARDB (2004) lists 2 species as vulnerable and 2 species as peripheral and CITES lists 5 species as C2 – i.e. Appendix 2 species. Some species have more than one conservation status (Annex 2).

The 65 species expected to occur in the general area consist of at least 2 tortoises (all vulnerable and protected game), 1 terrapin, 29 snakes (2 thread snake, 1 python, 1 burrowing snake, 2 quill snouted and 23 typical snakes) of which 1 species is classified as rare, 1 species as vulnerable and 4 species as endemic, 2 worm lizards, 8 skinks (of which 1 species is classified as rare), 7 old world lizards, 3 plated lizards, 1 monitor lizard, 2 agama, 1 chameleon and 7 geckos (Annex 2). The most important groups of reptiles expected from the general area are: Snakes (29 species), skinks (8 species), geckos (7 species) (Annex 2). Namibia with approximately 129 species of lizards 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 4 species were confirmed along the various seismic survey routes assessed and 15 species from the general area using the authors' previous records (Annex 2). This included 2 tortoises (Plate 5.2), 1 terrapin, 1 python, 6 typical snakes, 1 plated lizard, 1 monitor, 2 agama and 1 chameleon – i.e. a total of at least 15 species are confirmed from the general area – (Annex 2, Table 1). 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 and time spent in the field limited to various access routes and at various assessment points along these routes.

The most important species are viewed as those with some form of conservation status (Namibian and International – (Annex 2, Table 1) 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 most important species know/expected to occur in the general area would be the 2 species classified as rare (*Gonionotophis (Mehelya) vernayi*, *Sepsina angolensis*); 4 species classified as vulnerable (*Stigmochelys pardalis*, *Psammobates oculiferus*, *Python natalensis*, *Varanus albigularis*); 4 species classified as protected game (*Stigmochelys pardalis*, *Psammobates oculiferus*, *Python natalensis*, *Varanus albigularis*); 1 species classified as insufficiently known (*Gonionotophis (Mehelya) vernayi*) and 1 species classified as indeterminate (*Sepsina angolensis*). 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, Table 1.

The general area has been heavily impacted in places, especially close to towns, villages and settlements such as Oshivelo, etc.; crop production and land clearing on freehold farms; subsistence farming activities in communal areas, etc. and none of the unique reptiles are expected to be exclusively associated with the seismic survey routes in AOI00, AOI01 and AOI02. The proposed mitigations.

Plate 5.2: *Stigmochelys pardalis* (leopard tortoise) – vulnerable; peripheral; protected game; LC; C2 – juvenile observed crossing the D3007 in the AOI00 (Cunningham, 2022).

5.3.4.2 Amphibians

According to the literature, at least 17 species of amphibians can occur in suitable habitat in the general area. The area is under represented, with 1 rain frog, 3 toads, 1 pygmy toad, 1 kassina, 2 rubber frogs, 2 puddle frogs, 1 ornate frog, 2 platannas, 1 caco, 1 bullfrog and 2 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 (Annex 2).

During the fieldwork no amphibians were observed throughout the general area although there was some open surface water observed after localised rain showers (Plate 5.3). The lack of amphibians observed during the fieldwork could mainly be ascribed to limited time on site and lack of surface water throughout a sand dominated area.

The general area has been heavily impacted in places, especially close to towns, villages and settlements such as Oshivelo, etc.; crop production and land clearing on freehold farms; subsistence farming activities in communal areas, etc. and none of the unique amphibians are expected to be exclusively associated with the seismic survey routes in AOI00, AOI01 and AOI02.

The most important species from the area is the giant bullfrog (Pyxicephalus adspersus) with “populations are decreasing” according to the IUCN (2021) as it is consumed as food throughout its range (Griffin pers. com.). Most amphibians are expected to be associated with the ephemeral Omuramba Owambo and Omuthiya and various smaller pans throughout the general area (Plate 5.4).

Plate 5.3: Water collects in small pans in the AOI01 after localised rain showers in the area (Cunningham, 2022).

Plate 5.4: The ephemeral Omuramba Owambo flows through the area into the Etosha Pan and is viewed as the most important drainage line in the area (Cunningham, 2022).

5.3.4.3 Mammals

Of the species expected to occur in the greater area, 4 species are viewed as rare (Kerivoula lanosa, Zelotomys woosnami, Atelerix frontalis angolae, Civittictis civetta), 2 species endangered (Lycaon pictus, Equus (burchellii) quagga), 14 species vulnerable, 4 species specially protected game, 17 species protected game, 4 species indeterminate, 8 species insufficiently known, 4 huntable game, 3 problem animals, 14 peripheral and 6 not listed under Namibian legislation (Griffin and Coetzee 2005). The IUCN (2021) classifies 2 species as endangered (Loxodonta africana, Lycaon pictus), 5 species as vulnerable (Smutsia (Manis) temminckii, Acinonyx jubatus, Panthera pardus, Panthera leo, Aepyceros melampus petersi) and 2 species as near threatened (Macronycteris (Hipposideros) vittatus, Parahyaena (Hyaena) brunnea).

The SARDB (2004) classifies 1 species as endangered, 4 species as vulnerable, 12 species as near threatened and 5 species as data deficient while CITES lists 2 species as Appendix I and 9 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 Annex 2, Table 3 for the general area being the bats and rodents, as these groups have not been well documented from the arid north-central part of Namibia. At least 27.8% and 21.5% of the mammalian fauna that occur and/or are expected to occur in the general area are represented by bats (27 species) and carnivores (21 species) and rats and mice (21 species), respectively.

Habitat alteration and overutilization are the two primary processes threatening most mammals in Namibia (Griffin 1998c). Mammal species probably underrepresented in Annex 2, 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 8 species were confirmed along the various seismic survey routes assessed and 19 species from the general area using the author’s previous records. This included Damaraland mole-rat, black-backed jackal, striped polecat, yellow mongoose, slender mongoose, kudu, springbok and black-faced impala – i.e. a total of at least 8 species are confirmed from the general area – (Annex 2, Table 3). However, species such as elephant, lion, wild dog, etc. are only expected to move through the general area and not permanently associated with the area (Annex 2).

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. 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.

The most important species from the general area are probably those classified as rare (*Kerivoula lanosa*, *Zelotomys woosnami*, *Atelerix frontalis angolae*, *Civittictis civetta*), endangered (*Lycaon pictus*, *Equus (burchellii) quagga*) and vulnerable, under Namibian legislation and those classified by the IUCN (2021) as endangered (*Loxodonta africana*, *Lycaon pictus*), vulnerable (*Smutsia (Manis) temminckii*, *Acinonyx jubatus*, *Panthera pardus*, *Panthera leo*, *Aepyceros melampus petersi*) and near threatened (*Macronycteris (Hipposideros) vittatus*, *Parahyaena (Hyaena) brunnea*).

However, some of the above species – e.g. elephant, wild dog, etc. – only pass through the area – or are associated with game farms – zebra, black-faced impala – (i.e. introduced onto farms in the AOI00). The most important species expected to occur in the general area would be the African wild dog (*Lycaon pictus*) and pangolin (*Smutsia (Manis) temminckii*) (Annex 2).

5.3.4.4 *Birds*

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 Owambo or whilst moving between wetlands in Etosha and the Omudhiya Lakes (north of Etosha Pan) 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 45 species were confirmed along the various roads/tracks in the general AOI assessed of which 1 species is not included in Table 4 as it is a migratory species (i.e. steppe buzzard) and another 58 species from the general area using the author's previous records (Annex 2, Table 4).

However, many other aquatic species would be associated with the Etosha Pan and other pan systems throughout the area when water collects, but not included in Annex 2. The Omuramba Owambo may attract aquatic species in inland areas when water collects after rain showers.

The most important species are viewed as the 7 endemics and those classified as critically endangered (grey crowned crane, blue crane), endangered (southern ground-hornbill, Lüdwig's bustard, wattled crane, hooded vulture, white-backed vulture, bateleur, tawny eagle, booted eagle, martial eagle, yellow-billed oxpecker), vulnerable (lappet-faced vulture, white-headed vulture, secretarybird) and near threatened (Rüppell's Parrot, kori bustard, Verreauxs' Eagle, peregrine falcon, marabou stork) from Namibia (Simmons et al. 2015) and those classified by the IUCN (2021) as critically endangered (hooded vulture, white-headed vulture, white-backed vulture), endangered (Ludwig's bustard, grey crowned crane, lappet-faced vulture, bateleur, martial eagle, secretarybird), vulnerable (southern ground-hornbill, blue crane, wattled crane, tawny eagle) and near threatened (kori bustard).

An important species confirmed from the general area is the yellow-billed oxpecker. Although oxpecker numbers have increased in communal areas in northern Namibia (Robertson and Jarvis 2000), elsewhere they have been negatively affected due to arsenic-based cattle dips.

5.3.5 Flora Diversity

5.3.5.1 Trees and Shrubs

The tree and shrub diversity known and/or expected to occur in the general PEL 93 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, Tables 5 and 6. Annex 2, Table 5 indicates tree and shrub diversity within the various AOI (i.e. general seismic routes) while Annex 2, Table 6 indicates tree and shrub diversity at each of the 46 vegetation survey points conducted within the AOI (30 x AOI00; 8 x AOI01; 8 x AOI02).

At least 95 species of larger trees/shrubs are expected to occur in the general area of which none are viewed as endemics. Eighteen species (18.9%) are protected by the Forest Act No. 12 of 2001 while 1 species is protected by the Nature Conservation Ordinance No. 4 of 1975 (1.1%) (Mannheimer and Curtis 2018). Two species are classified as Lower Risk (Near Threatened) (2.1%) (Loots 2005). Species with the most diversity expected from the general area are *Acacia* (16 species) and *Combretum* (12 species) and followed by *Grewia* (10 species).

During the fieldwork a total of 51 larger trees and shrubs was confirmed from the various AOI with the AOI00 (40spp.), AOI01 (26spp.) and AOI02 (24spp.) declining in species composition from south to north (Annex 2, Table 5 and Table 6a-f). Of these 51 species, 7 species are protected by the Forest Act No. 12. of 2001 – i.e. 13.7%. The actual vegetation survey points varied between 7 and 16 species, respectively (Annex 2, Table 6a-g).

The most important larger tree and shrub species expected to occur in the general area include all those formally protected (Annex 2, Tables 5 and 6a-g) with the most important species viewed as *Baikiaea plurijuga*, *Burkea africana* and *Sclerocarya birrea.* Another important species, classified as Lower Risk/Near Threatened by the IUCN (2021), is *Pterocarpus angolensis* (African teak or Kiaat) (De Cauwer *et al.* 2014) while *Baikiaea plurijuga* (Zambezi/Rhodesian Teak) is viewed as the most important in the general area due to numbers having decreased due to overutilisation for wood production; elephant damage and unseasonal human induced fires (Plates 5.5-5.11).

The most important areas are viewed as the Omuramba Owambo; Omuramba Omuthiya other Omuramba's and pans throughout the general AOI (Annex 2).

The following is the summary of the most dominant tree and shrub species around AOI00, AOI01 and AOI02:

- The most dominant tree and shrub species throughout the AOI00 are *Acacia mellifera* (black thorn), *Acacia reficiens* (red-bark Acacia), *Combretum apiculatum* (kudu bush), *Combretum hereroense* (mouse-eared Combretum), *Dichrostachys cinerea* (sicklebush), *Spirostachys africana* (tamboti) and *Terminalia sericea* (silver cluster leaf) (Plate 5.12).

- The most dominant tree and shrub species throughout the AOI01 are *Acacia erioloba* (camel thorn), *Acacia mellifera* (black thorn), *Baphia massaiensis* (sand camwood), *Combretum hereroense* (mouse-eared Combretum) and *Terminalia sericea* (silver cluster leaf) (Plate 5.13).

- The most dominant tree and shrub species throughout the AOI02 are *Acacia ataxacantha* (flame thorn), *Baikiaea plurijuga* (Zambezi teak), *Baphia massaiensis* (sand camwood), *Combretum collinum* (variable Combretum), *Dichrostachys cinerea* (sicklebush) and *Terminalia sericea* (silver cluster leaf) (Plate 5.14).

5.3.5.2 *Grass*

Although up to 116 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 – *Eragrostis pallens* and *Cymbopogon* species – which also have economic value, are the important grasses in the area (Annex 2).

During the fieldwork a total of 33 grasses were confirmed from the various AOI with the AOI00 (28spp.) having the highest species diversity followed by the AOI01 (17spp.) and the AOI02 (10spp.) (|Annex 2, Table 7). The AOI02 is heavily overgrazed throughout with the D3659 serving as a cattle thoroughfare between fields and communal farms.

Dense stands of grass occur in open areas and/or along road verges in the AOI00 and AOI01 (Plates 5.15 and 5.16).

The most dominant grass species throughout the AOI00 (dependent on soil, grazing regime, fire frequency, bush densities, etc.) are *Aristida adscensionis* (annual bristle-grass), *Aristida meridionalis* (giant bristle-grass), *Enneapogon cenchroides* (common nine-awned grass), *Eragrostis superba* (heartseed love-grass), *Eragrostis trichophora* (smooth love-grass), *Heteropogon contortus* (spear grass), *Stipagrostis uniplumis* (silky Bushman-grass) and *Urochloa brachyura*. *Dactyloctenium giganteum* (giant crowfoot), *Eragrostis trichophora* (smooth love-grass) and *Tragus berteronianus* (small carrotseed grass) are dominant in the AOI01 while *Digitaria seriata* (Kuruman finger grass) and *Urochloa brachyura* are dominant in the AOI02 (Annex 2).

Plate 5.5: *Albizia anthelmintica* (worm cure Albizia) – protected – are important medicinal and fodder trees in the general area (AOI01) (Cunningham, 2022).

Plate 5.6: *Baikiaea plurijuga* (Zambezi teak – Near Threatened, IUCN 2021) – protected – has been targeted extensively for illegal logging purposes (AOI01) (Cunningham, 2022).

Plate 5.7: *Burkea africana* (burkea) – protected – are some of the taller trees in the area and are targeted for timber and firewood production (AOI02) (Cunningham, 2022).

Plate 5.8: *Combretum imberbe* (leadwood) – protected – are some of the larger and more important protected tree species in the area (AOI00) (Cunningham, 2022).

Plate 5.9: *Hyphaene petersiana* (makalani) – protected – stands are often nesting sites for vultures and other large raptors in the general area (AOI00) (Cunningham, 2022).

Plate 5.10: *Sclerocarya birrea* (maroela) – protected – are important fruit trees (Cunningham, 2022).

Plate 5.11: *Spirostachys africana* (tamboti) – protected – are important trees for fence poles and droppers as they are termite resistant (Cunningham, 2022).

Plate 5.12: Dense impenetrable stands of *Dichrostachys cinerea* (sicklebush) are dominant in large parts of the AOI00 (Cunningham, 2022).

Plate 5.13: *Terminalia sericea* (silver cluster leaf) is dominant in the AOI01 (Cunningham, 2022).

Plate 5.14: *Acacia ataxacantha* (flame thorn) and *Combretum collinum* (variable Combretum) are some of the dominant species in die sandy AOI02 (Cunningham, 2022).

Plate 5.15: A large variety of perennial grass species are found in the AOI00 (Cunningham, 2022).

Plate 5.16: *Dactyloctenium giganteum* (giant crowfoot) are dominant in open areas in the AOI02 (Cunningham, 2022).

5.3.6 Important Habitats

Important habitats in the general area are: Omuramba Owambo, Omuramba Omuthiya, Etosha National Park and the Mangetti Block which is an important elephant movement between the Etosha National Park and the Mangetti farms (Annex 2).

The general PEL 93 area has been heavily impacted in places, especially close to towns, villages, and settlements such as Oshivelo, etc.; crop production and land clearing on freehold farms; subsistence farming activities in communal areas, etc. (Plates 5.17 and 5.18 and Annex 2).

The most important habitat areas in the general PEL 93 and surrounding areas are (Annex 2):

1. Ephemeral Omuramba Owambo and Omuthiya: 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). In a sandy area with very little surface water, these rivers are seasonal lifelines and habitat to numerous vertebrates.

2. 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). The Etosha pans and various other smaller pans in the greater Omudhiya Lakes area are also viewed as important habitat to a variety of aquatic birds and the critically endangered cranes.

3. Etosha National Park: The Etosha NP on the western boundary of the AOI is the flagship of the parks in Namibia with hundreds of species of mammals, birds and reptiles, including several threatened and endangered species such as black rhino, cheetah, elephant, lion, white rhino, etc. as well as a breeding site for the critically endangered blue crane (Ntinda *et al.* 2012; www.met.gov.na and Annex 2).

4. Mangetti Block: The Mangetti Block is located to the immediate east of the AOI and is important as an elephant migration route between the Etosha NP and the Okavango River (and Angola) and the Mangetti and Kaudum NP's including a small wild dog population which also occurs in this area (Annex 2), and.

5. 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.), north of the Veterinary Cordon (i.e. communal area) and more recently along the various tracks and roads throughout the area, including long term farming impacts on freehold farms south of Oshivelo (Plates 5.17 and 5.18 and Annex 2). However, there are some areas far from the 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, the seismic surveying will mostly be conducted on existing access routes throughout the area.

Plate 5.17: Example of extensive land clearing activities in the AO102 north of Oshivelo affects the presence and abundance of mammals throughout the general area.

Plate 5.18: Example of extensive land clearing activities in the AO100 southeast of Oshivelo affects the presence and abundance of mammals throughout the general area.

5.4 Socioeconomic Setting

5.4.1 Overview

PEL 93 and the AOI for the proposed 2D seismic survey falls with the Oshikoto Region with a total land area of 38 653 km^2, the Oshikoto Region occupies 4.69% of the country`s total land surface and is home close to 200 000 people, making 8.4% of Namibia's population (Annex 3). The region is named after Lake Otjikoto and its capital is Omuthiya. The city of Tsumeb, Otjikoto's capital until 2008, and the towns of Omuthiya and Oniipa are also situated in this region (Annex 2).

The region's population has grown significantly over the past years, partly as a result of redistribution within the Oshiwambo-speaking area. Apart from Tsumeb and Oniipa, people have settled in a corridor along the trunk road, occasionally forming fairly dense concentrations.

Most of the Oshikoto population is concentrated in the northwestern part of the Region while the license area is located in the eastern part of Oshikoto Region. The area of interest is populated with around 31 660 people, however this is together with the population of Eengodi constituency which is the most populated of all three affected constituencies (NSA, 2014a). Though the 2D seismic survey lines are touching a small area of the eastern part of Eengodi constituency (Fig. 5.7) and where population is relatively small.

The greater parts of the license area are general sparely populated considering that it is characterized by vast remote localities and cattle post areas (Annex 3). According to the 2011 Population and Housing Census data, Oshikoto Tables that are based on 4th Delimitation, and data of the Oshikoto Regional Council, the following is the population size of constituencies that are located in the area of interest (Table 5.1).

The 2011 Census and 2016 Inter-Census data revealed that female population is larger than male population in Oshikoto Region (NSA, 2014 and 2017a). In a period between 2011 and 2016, the female population shrunk from 52.2% to 51.8% and male population grew from 47.8% to 48.2%, thus the gender ratios are slightly balanced out. The sex ratio of Oshikoto Region was 92 in 2011 and 93 in 2016. There are slight differences within the Region (Fig. 5.7*)*. The sex ratios are higher in western constituencies than in eastern constituencies, meaning there are higher proportion of females to males in western constituencies than in eastern constituencies which are more balanced.

The northern part of the region is crop agriculture, whereas the main economic activities in the southern part are cattle rearing and mining. The two areas have important cultural and historical links in that the Ndonga people have extracted copper at Tsumeb since the earliest times in order to make rings and tools. Pearl millet (Mahangu) is the principal crop in the north, while cattle are reared in the Mangetti and the Tsumeb district. Although the Tsumeb mine has only a limited life span, it can together with the associated support industries and services, provide a boost for the communal areas of the region.

Communication is good in much of the area: a paved trunk road runs across the region, linking it to both the south and the north of the country. The national microwave network terminates at Tsumeb, but telecommunications are now carried across the region and as far as Oshakati by means of a newly laid optical fiber cable.

Table 5.1: Population size by area and density (Source of data: Oshikoto Regional Council, 2020; NSA, 2014a).

Constituency	Population	Area in sq.km
Guinas	5 460	4569.91
Eengodi	15 490	2107.77
Nehale LyaMpingana	10 710	9934.99

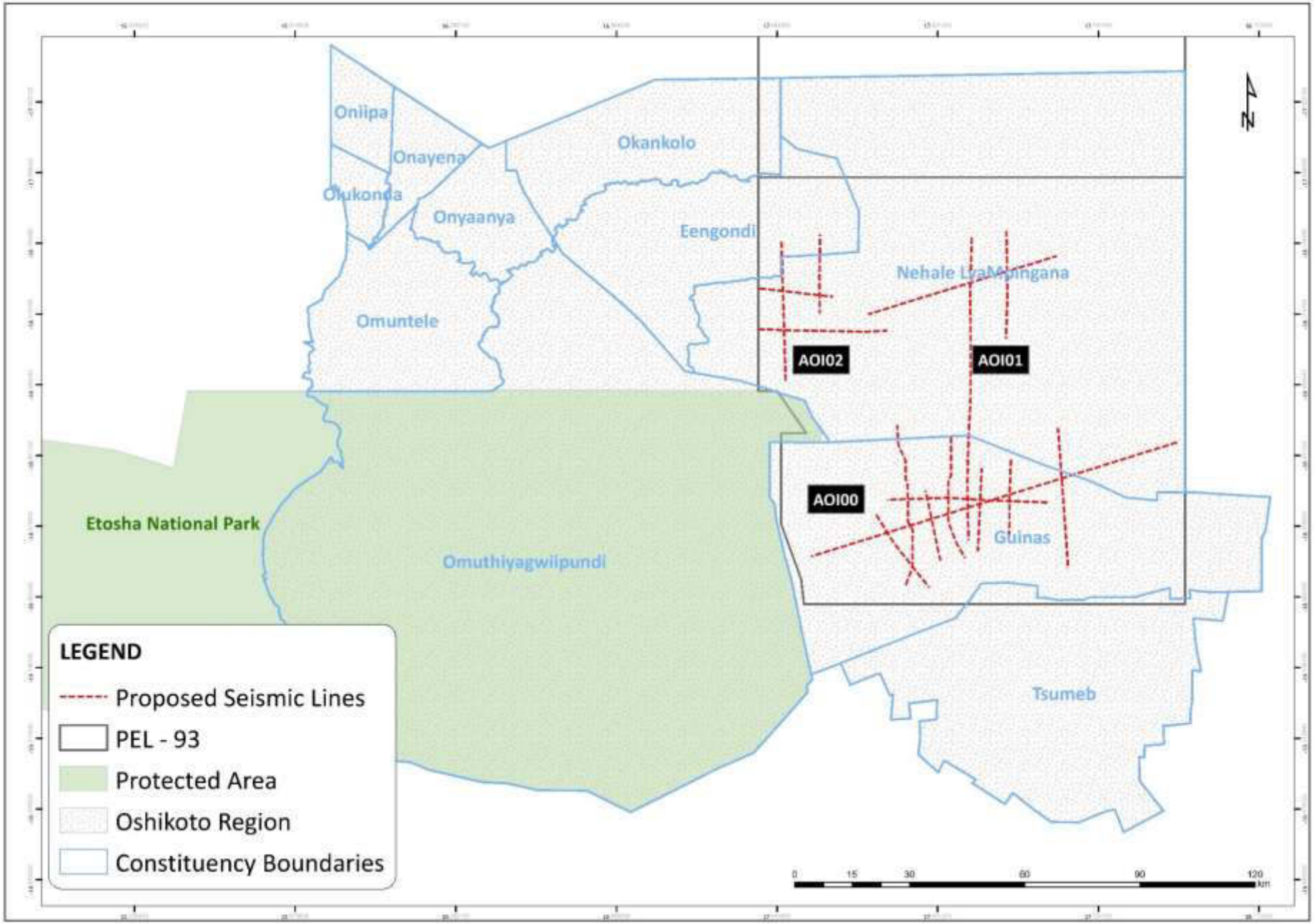


Figure 5.7: Detailed location of the key exploration Areas of Interest (AOI) and proposed 2D seismic survey lines with respect Constituency boundaries for Oshikoto Region.

5.4.2 Socioeconomic Summary of PEL 93 and AOI

The following is the summary of the socioeconomic information covering PEL 93 in Oshikoto Region and the AOI (Annex 3):

- The area of interest is populated with around 31 660 people, this includes 3 constituencies - Guinas, Eengodi and Nehale LyaMpingana.
- There are more females than males, 51.8% and 48.1% accordingly.
- Eengodi and Nehale LyaMpingana constituencies has more youthful population than Guinas constituency. Though Guinas has highest percentage of working age population among the three affected constituencies and which is above the average for Namibia (57.3%).
- Approximately 62% of population aged 15 years and above in Oshikoto Region were never married, while 22.7% of the population were married with certificate.
- There are more single males in Nehale LyaMpingana and Eengodi constituencies, while Guinas constituency has more single females.
- Oshikoto teenage pregnancy rate stands at 1.4% of all children ever born to females younger than 20 years of age.
- 6.7% of the total population of Oshikoto Region has some kind of disability. The proportion of people living with disabilities is higher in rural areas (6.9%) than in urban areas (5.4%).
- The physical impairment of lower limbs is the most common type of disability affecting about 24% of the population with disabilities in Oshikoto Region.
- Oshikoto Region's life expectancy is at 61.8 years for females and 52.2 years for males. This is a considerable improvement in comparison to the earlier Census 2001 when female's life expectancy was only 49.8 years and 50 years for males.
- Population of Oshikoto Region has been growing steadily, yet at a slightly slower paste than average for Namibia. In a period between 2001 and 2011 the annual growth rate for Oshikoto was 1.2% and then it slightly picked up to 1.4% in 2016.
- The projected population of Oshikoto Region for 2030 is 235153 people, with 48.4% being male and 51.6% female.
- The area is sparsely populated in east, south and south east part (Etosha National Park) of the Oshikoto Region and densely population in northwest part of region.
- There is a noticeable movement of people from rural to urban areas. The long-term migration for Oshikoto Region is negative. There were more people leaving the area than coming in.
- The literacy rates in Oshikoto Region is 84%, with females scoring higher rate of 87% and males lower 81%.
- The literacy rates for affected constituencies had lower rates than the rest of the Oshikoto Region. Particularly low literacy rates were in Guinas constituency where only 64% of males and 56% of females were literate.
- Oshikoto Region's unemployment rate is 36.2% which is above the unemployment rate for Namibia - 33.4%.
- The large unemployment rate could be attributed to the limited formal employment within the region as the majority of households still obtain income from subsistence activities.

- Largest share of employed people work as skilled agricultural workers, in elementary occupations, service workers and craft and related trade workers. Nehale LyaMpingana Constituency has a significant number of employed who work in armed forces.

- Dependency on old-age pensions, cash remittances, retirement fund, orphan or disability grants is high and indicates dependency from income that is coming from social services or monies that are not generated by themselves. Around 15% of Eengodi households, 13.5% Guinas households and 9.1% Eengodi households depend on old-age pensions.

- In 2011, the incidence of poverty in Oshikoto Region was 43 % and it represented a 15-percentage point reduction from the 2001 figure of 57 %. Though there was an improvement since 2001, Oshikoto Region is among the three poorest regions in Namibia.

- Oshikoto household consists of 4.3 persons on average. There are more female headed households than male headed households.

- Around 2% of households are headed by children who were 18 years and younger. Oshikoto Region has one of the highest number of households headed by children! Furthermore 0.7% of households are headed by orphaned children.

- Traditional dwellings are the most common type of housing unit, making up 69.7 % of all households in Oshikoto Region, followed by detached houses (14.2%) and semidetached houses (6.1%).

- Household's main source of energy for cooking was fire wood, 70.9% of all households using fire wood for cooking. The main source of energy for lighting is battery lamps, torches and cell phones - 56.6% of Oshikoto households.

- 93% of households have safe drinking water, with 30.3 % of the households having access to piped water inside the house and 38.2% of households having piped water outside.

- Oshikoto Region has traditionally been occupied by San groups, mainly Hai||om and with a smaller proportion of !Xun – living mostly in the freehold areas, with just a few groups living in the communal areas. After Independence many Hai//om farmworkers were dismissed and moved to towns or newly established resettlement farms, such as Tsintsabis. In 2012 the Hai//Om San community living at Oshivelo was resettled to Ondera. In 2018 Ondera had already 500 households.

- Oshikoto Region's economic environment is largely made up by farming, tourism and mining.

- Agriculture is one of the key sectors in the Oshikoto Region. Region is 'divided' into two different land tenure regimes. The southern part of the Region consists of large-scale farming areas under freehold title, while the north-western parts remain under communal land.

- Most of the households in the communal area engage in the subsistence farming. Commercial farming is mostly practiced beyond the veterinary cordon fence popularly known as the red line.

- Tourism is often cited as one of the major contributors to the regional economy. Etosha National Park is the biggest and most famous tourist attraction area in the Region. Other tourist attraction sites are: Otjikoto Lake, Guinas Lake, the Nakambale and Helvi Kondombolo Cultural Villages and Tsumeb museum.

- Trade in Oshikoto Region is represented by formal and informal traders ranging from multinational retail businesses to vendors selling home-made food (fat cakes, cooked meat, fish etc) home-made drink (Oshikundu) and many others. Apart from the informal traders, most of the businesses are liquor wholesalers and outlets as well as small shops, selling basic amenities and foodstuff.

- Tsumeb is well known for its copper mine, which was built in 1961-1962 and houses one of the few commercial smelter plants in Africa. Dundee Precious Metals' copper smelter is one of only a few in the world that can treat complex copper concentrates and employs approximately 800 people. The estimated life of mine is until 2038.

- According to the government officials the Oshikoto Region has an enormous economic potential, specifically in the areas of mining, tourism, livestock and crop farming, and.

- Impact of Covid-19 pandemic on the local economy was huge. All sectors from shebeens, SMEs and tourism and hospitality establishments were severely affected in Oshikoto, and many have failed to revive themselves despite regulations having been relaxed.

5.5 Subsurface Ground Components

5.5.1 Regional Geology

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. 5.8 -5.10).

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. In the Etosha Basin the Nosib, Otavi and Mulden Groups of the late Precambrian Damara Sequence rest on a basement of mid Proterozoic gneisses, granites, volcanic and metasedimentary rocks (Miller, 1992 and 2008). According the Miller, (1992), these are overlain by up to 6000 m of extensive platform carbonates of the Otavi Group, which were laid down on the shallow and relatively stable Northern Platform of the Orogen as rifting evolved to spreading and ocean formation to the south and west between 730 and 700 million years (Figs. 5.8 -5.10).

According to Miller, (1992), fluviatile feldspathic quartzites, arkoses and conglomerates of the basal Nosib Group were deposited in the Etosha Basin during intracontinental rifting in branches of the Damara Orogen to the south and west. The thickness of the stratigraphic units increases from the margin of the basin towards the Centre, especially from the Ghanzi Ridge in the north, which formed a high during sedimentation of the Karoo Sequence (Fig. 2-2). Various periods of uplift and exposure led to palaeokarsting at the base and top of the Abenab Subgroup and at the top of the Tsumeb Subgroup. Spreading ceased at about 700 million years. Reversal of plate motion and subduction eventually culminated in continental collision in all branches of the Damara Orogen. D1 deformation in the orogen between 700 and 650 million years ago led to uplift of the Etosha Basin, particularly the western margin (Figs. 5.8 -5.10).

The Mulden sedimentary rocks are proximal in the west and distal in the east (Miller, 1992). The Tschudi Formation arkose at the base (+ 500 m thick), itself a with 350 m maroon basal siltstone in the west, is followed by four upward-fining cycles of the Kombat Formation. The top of the first cycle, the Black Shale Member, is a 93 m thick dense, very dark grey to black carbonaceous shale that has a distinctive electric log trace, is a prominent seismic reflector and is an excellent marker bed throughout the Etosha Basin (Fig. 2-4 and Hedberg, 1979). Momper (1982) reports VR values of 0.73 to 1.08 and TOC up to 2.8 wt%. Shales at the top of each of the overlying cycles are green to grey in colour. The uppermost unit of the Mulden Group, the Owambo Formation, consists of four upward-fining cycles of varicoloured sedimentary rocks. Three of the cycles are capped by dolomite. Shale and dolomite are usually grey in colour (Miller, 1992, 2008).

The Karoo Sequence overlies the Owambo Formation unconformably and occurs in a relatively small part of the central Etosha Basin (Figs. 5.8 -5.10). The basal glaciogenic sedimentary rocks of the Dwyka Formation are overlain by up to 220 m of lower Permian carbonaceous shales and interbedded

high-ash coals of the Prince Albert Formation (Miler, 1992). Over 130 m of aeolian sandstone of the Jurassic. Etjo Formation occurs in a well at the Nanzi Pan. Basalts occur in the eastern part of the Etosha Basin. Mulden Group and Karoo Sequence rocks in the Etosha Basin are covered entirely by sands, clays and calcretes of the Kalahari Sequence which exceed 400 m in thickness in the northeast (Figs. 5.10-5.14).

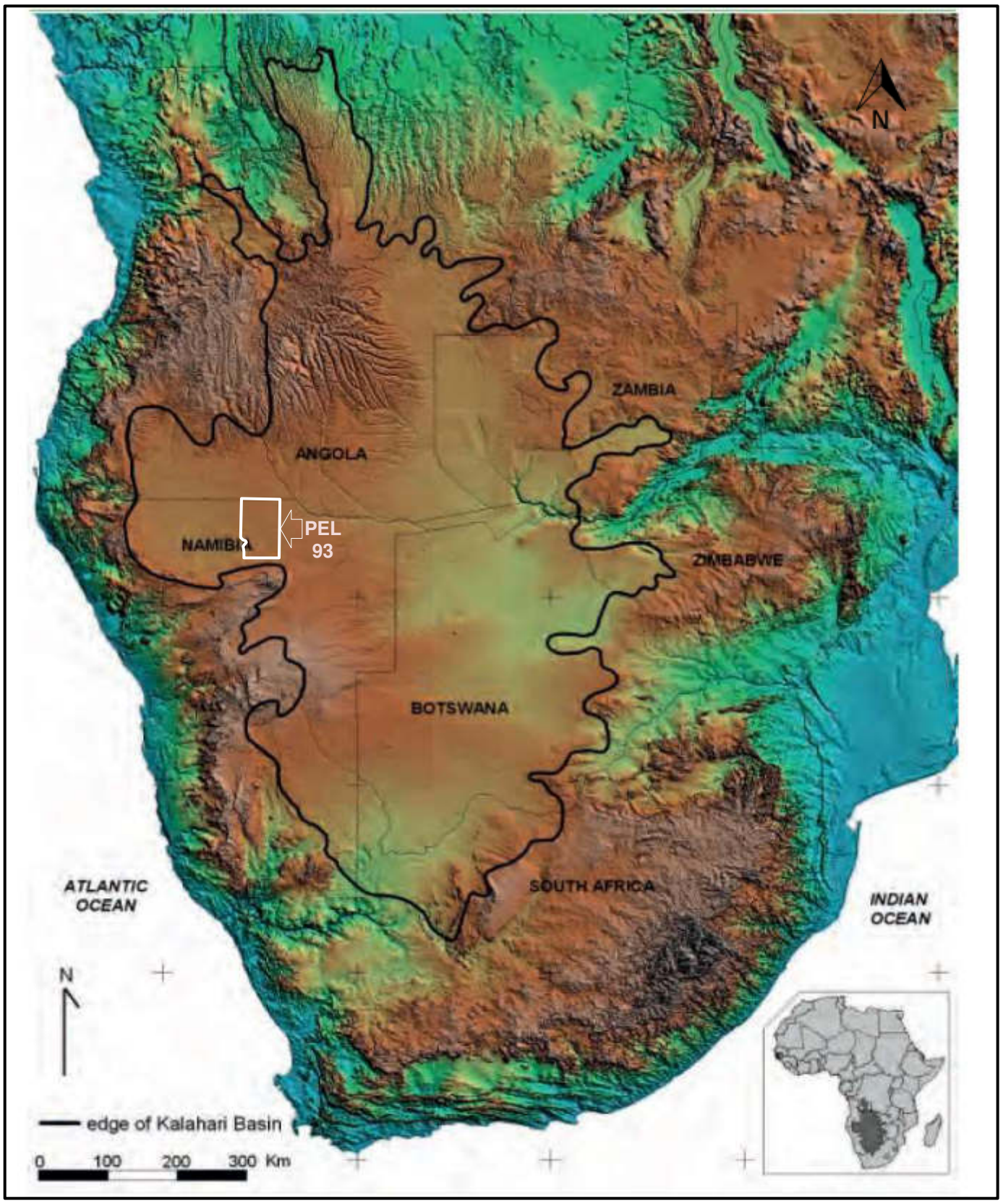


Figure 5.8: Lateral extent of Kalahari Group sediments (Source: Haddon, 2005).

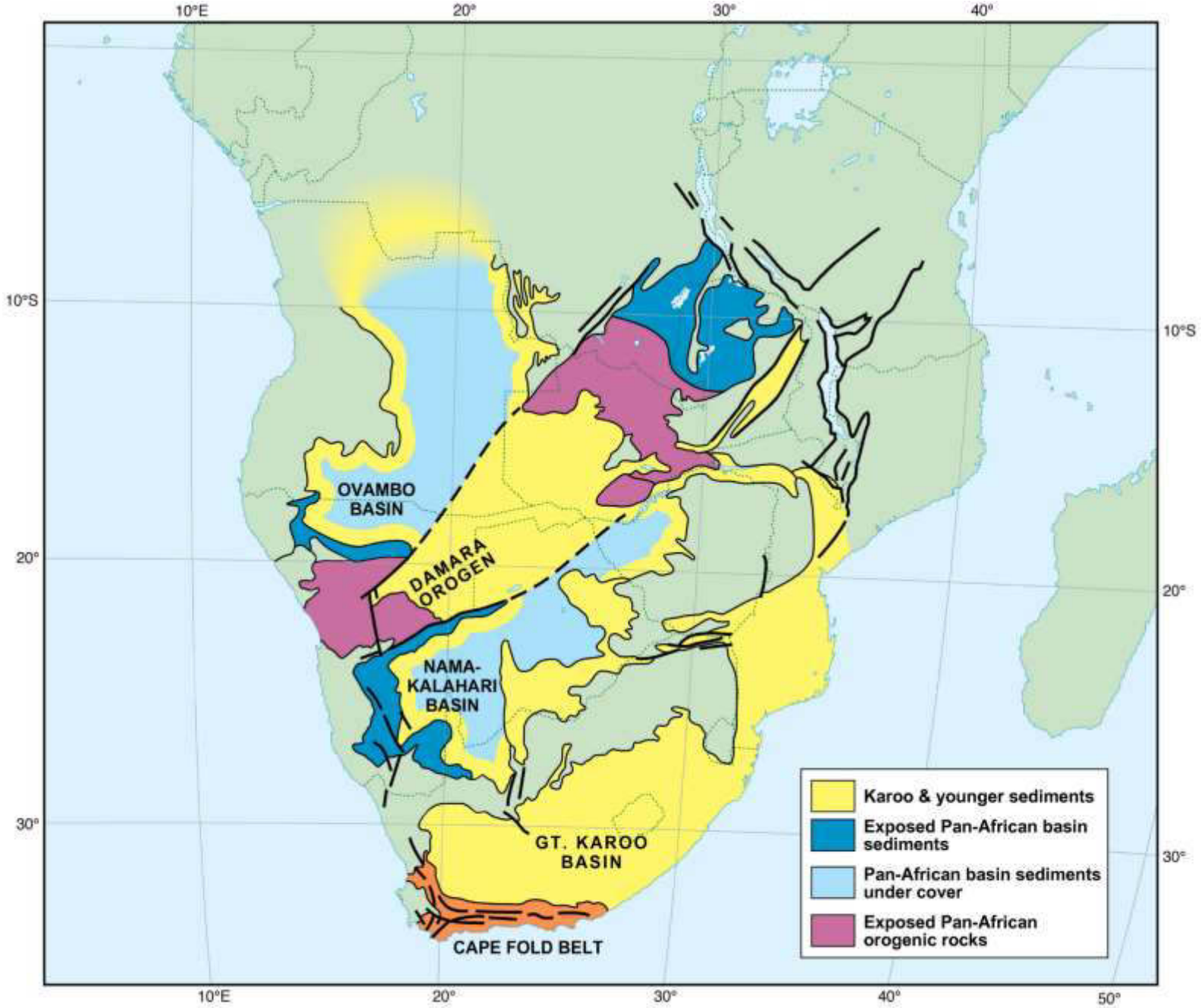


Figure 5.9: The Owambo (Etosha) Basin, location of PEL 93 within the context of the late Proterozoic/Early Palaeozoic and Karoo basins of Central and Southern Africa (Source: Lawrence, *et. al.,* 2014).

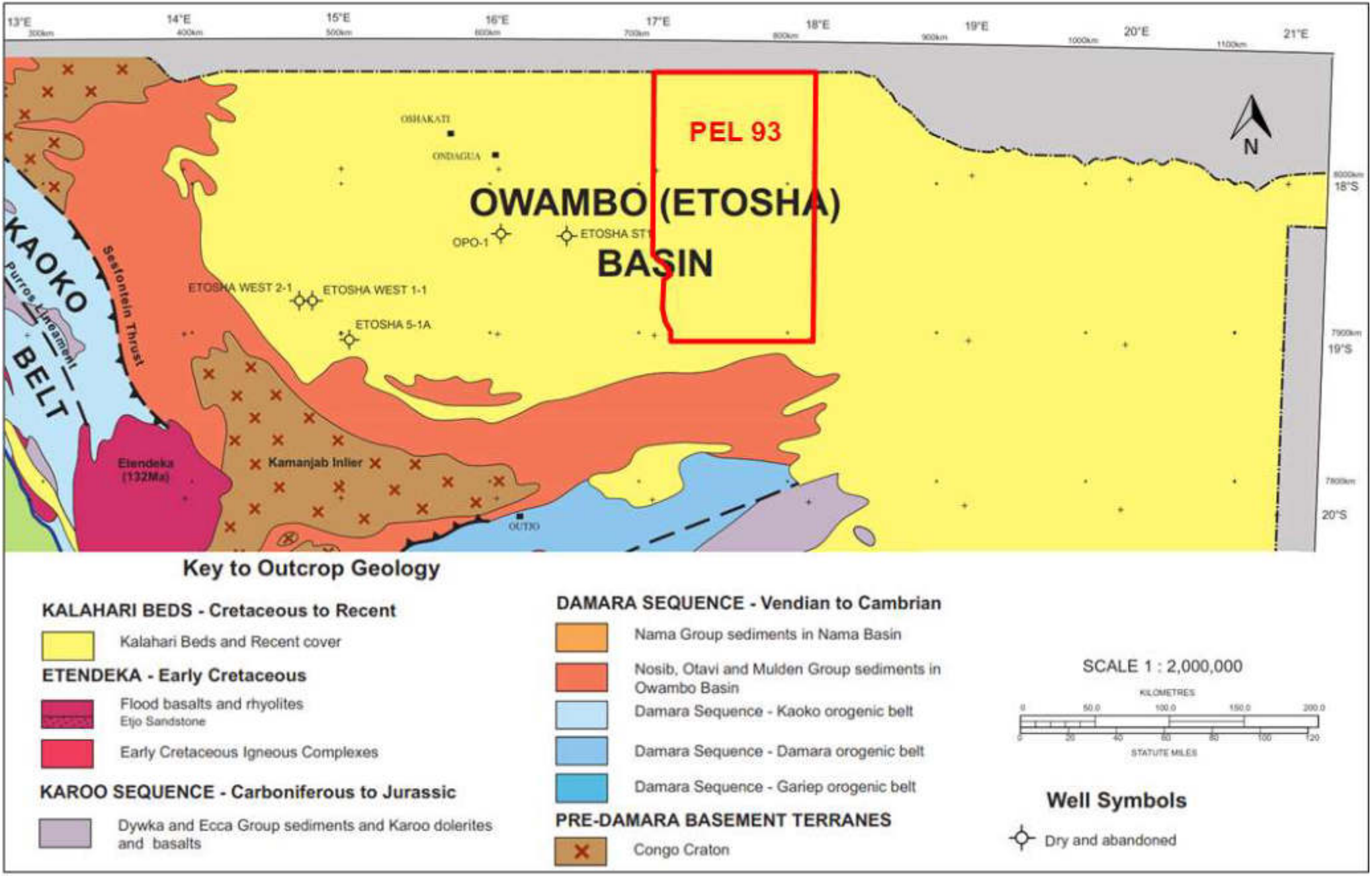


Figure 5.10: Geological map of northern Namibia showing Owambo (Etosha) Basin and the associated regional structural elements (Extract from Namcor, Ministry of Mines and Energy, 1998).

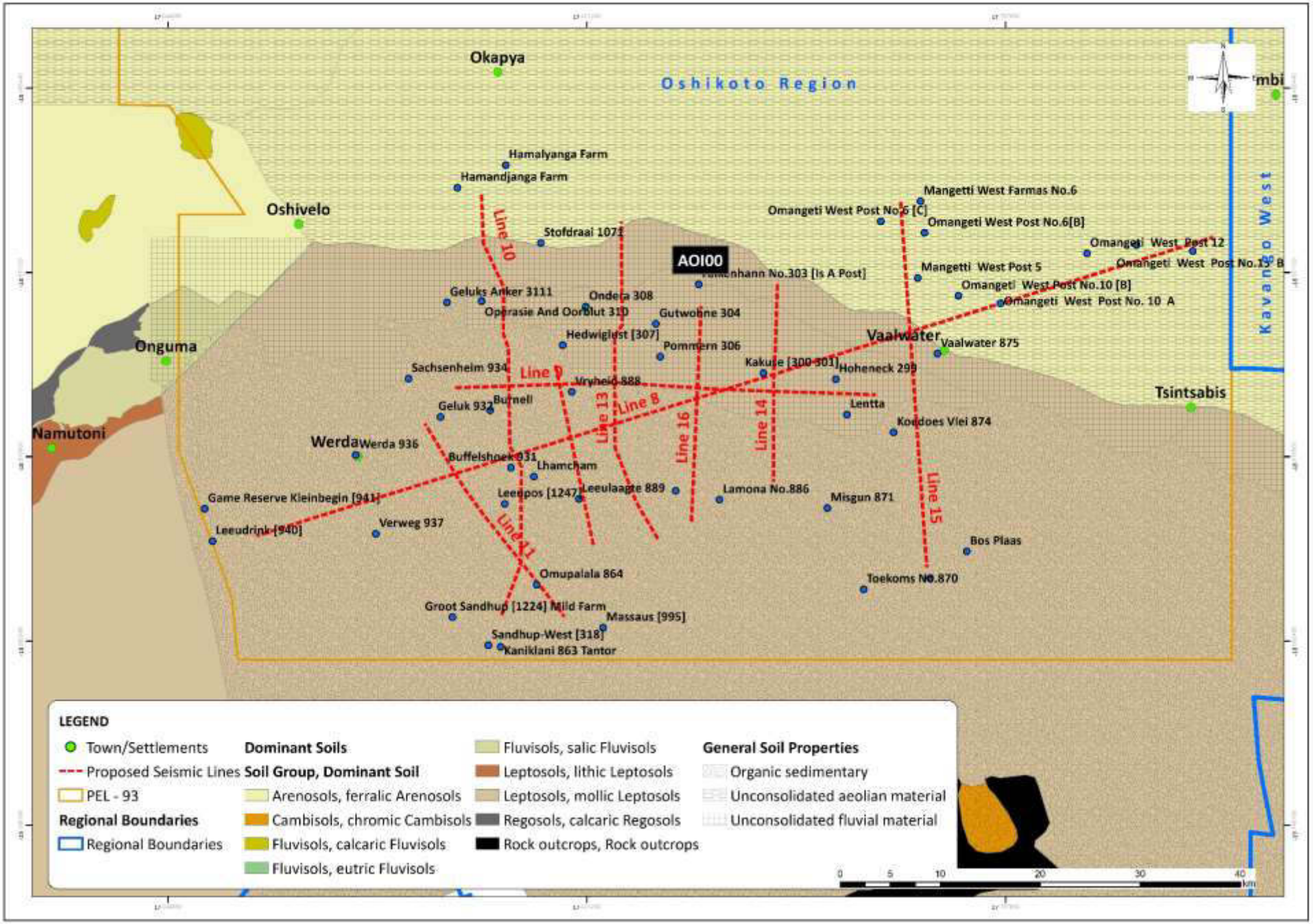


Figure 5.11: Surficial geology of PEL 93 and the proposed survey area showing the Prospect AOI00.

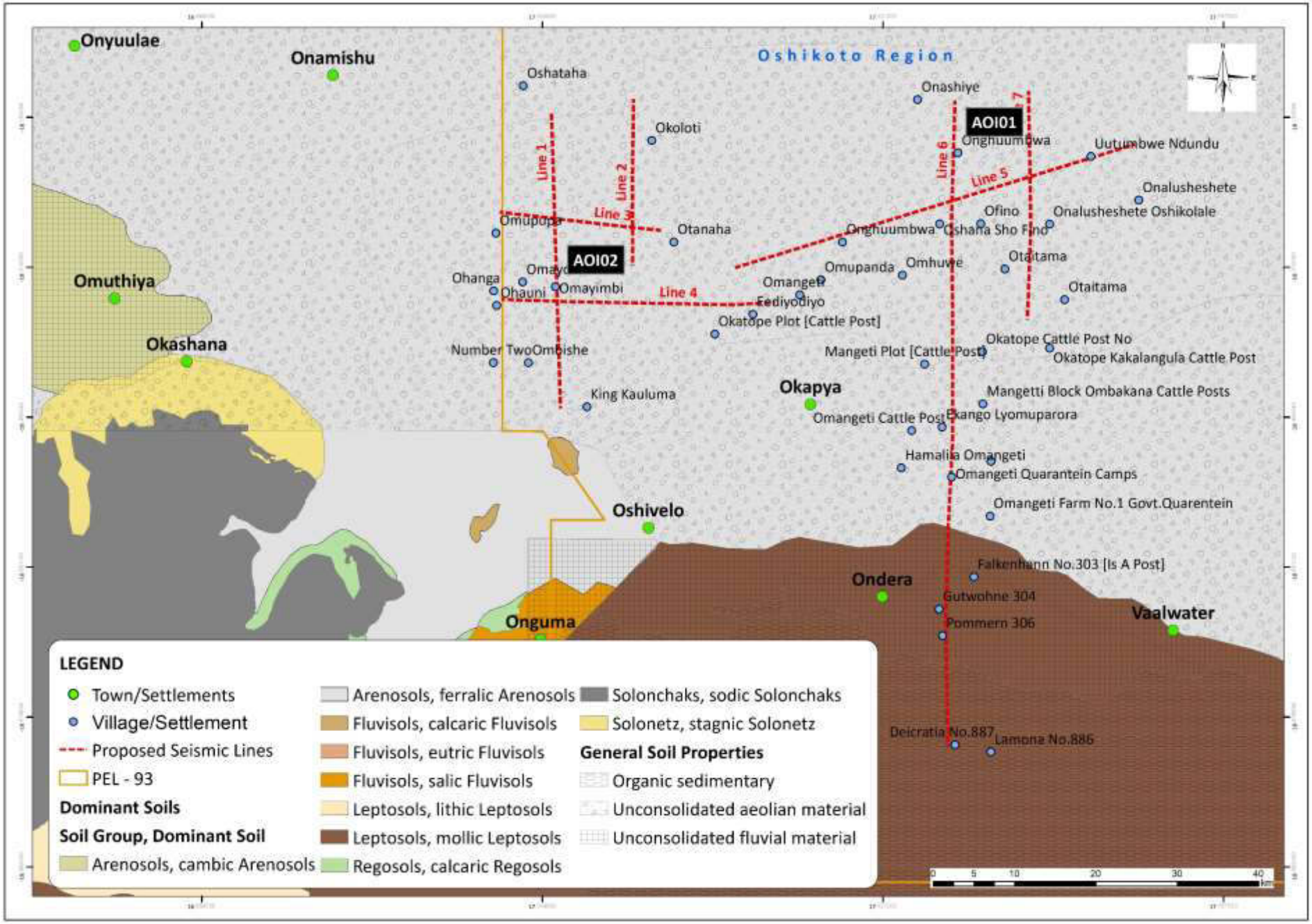


Figure 5.12: Surficial geology of PEL 93 and the proposed survey area showing the Prospects AOI01 and AOI02.

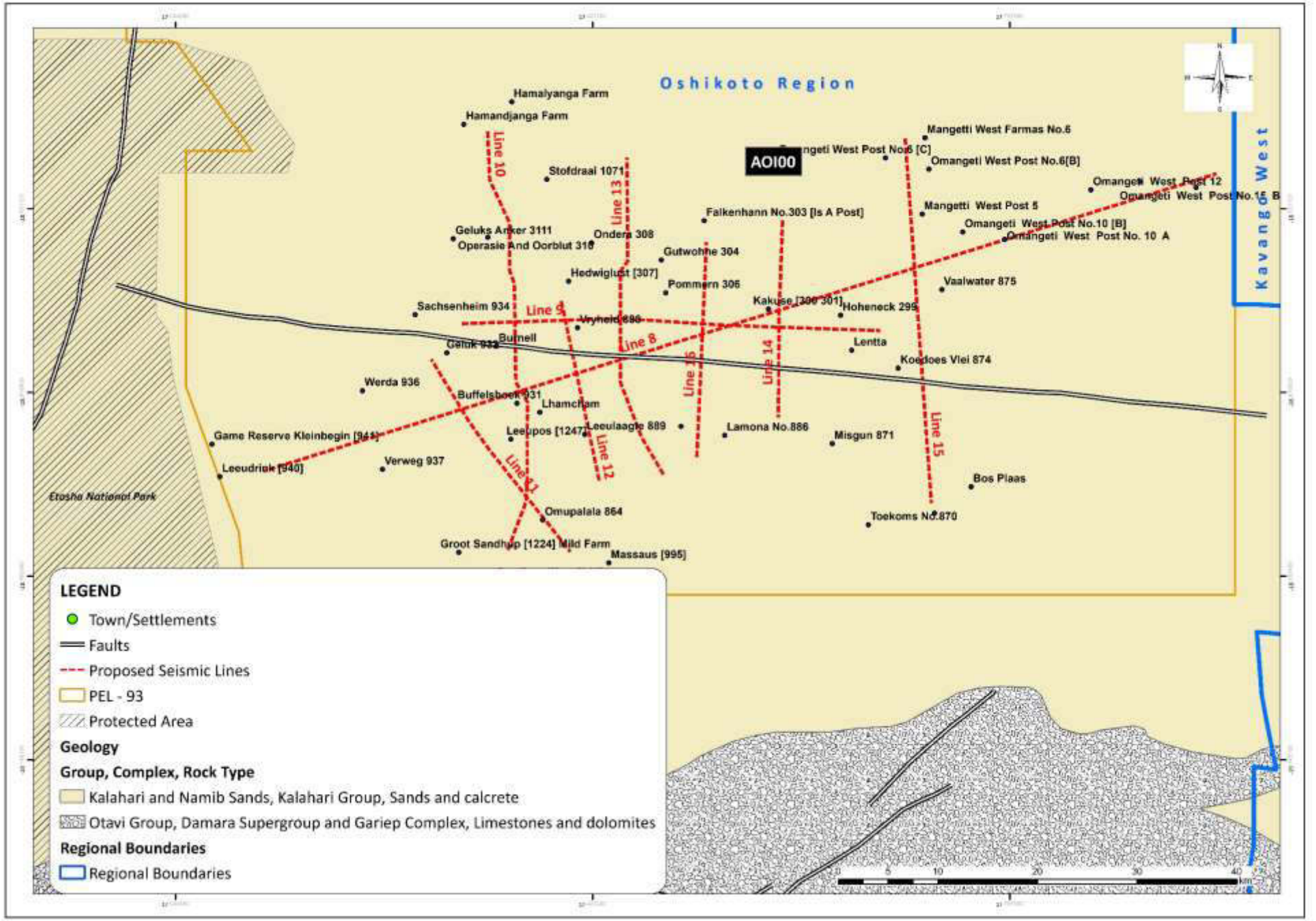


Figure 5.13: Solid geology of PEL 93 and the proposed survey area showing the Prospect AOI00.

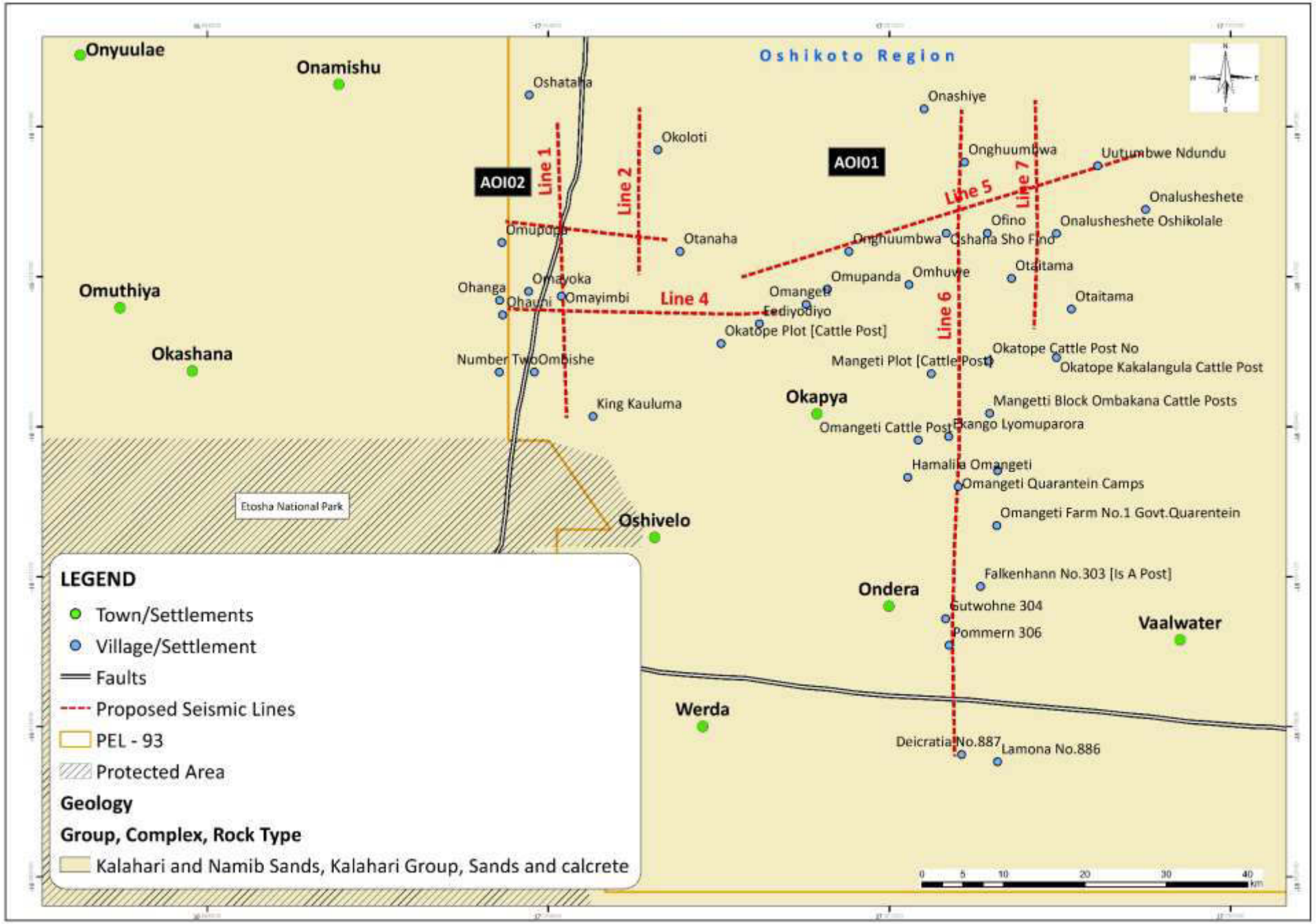


Figure 5.14: Solid geology of PEL 93 and the proposed survey area showing the Prospects AOI01 and AOI02.

5.5.2 Petroleum System

5.5.2.1 Overview

According to MEL, (2022), the evolution of the basin through geological time favoured the conditions for the essential elements and processes of the petroleum system to be formed (i.e., source rock, reservoir, seal, trap formation, maturation, generation, expulsion and migration of hydrocarbons from source to traps). Otavi Group, a Neoproterozoic carbonate platform, represents the main target (Figs. 5.15 and 5.16 and www.monitorexploration.com).

5.5.2.2 Exploration Source Rock, Reservoir and Trap Targets

The source rocks with favourable generation potential are associated with the Otavi Group carbonates (www.monitorexploration.com and MEL, 2022). Potential reservoir rocks in the Owambo basin include Proterozoic carbonates of Otavi and sandstones of the Mulden group. Intra-Damara paleokarst structures may have lost of their porosity but various post-Damara episodes of karsting have produced cavernous porosity which is a major source of groundwater in the basin margins. The exploration targeting traps likely to be associated with the antiformal structures, carbonate mounds and tectonic inversion anticlines (www.monitorexploration.com and MEL, 2022).

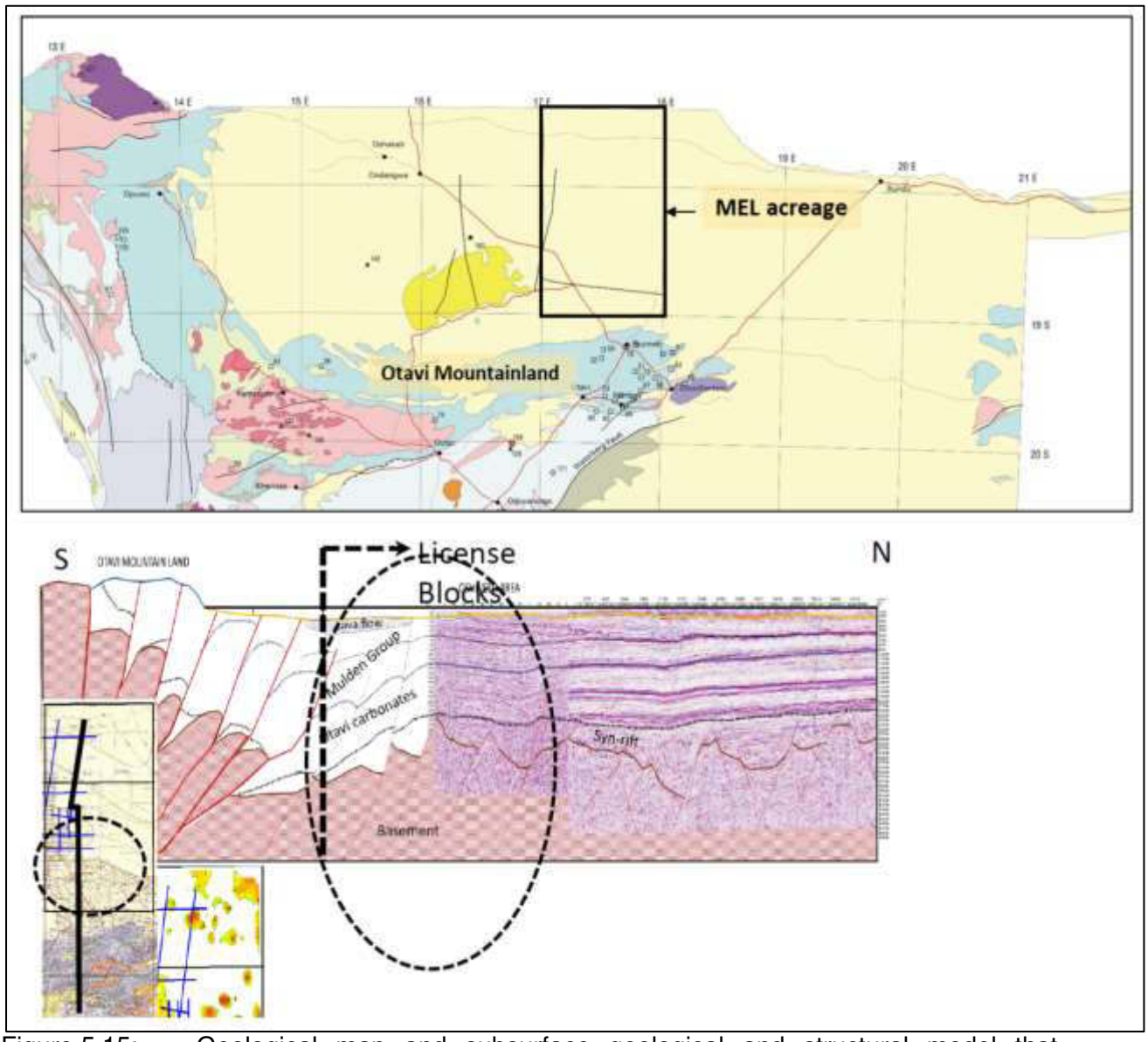


Figure 5.15: Geological map and subsurface geological and structural model that suggests the existence of large structural traps towards the southern portion of the block 1817 (Source: MEL, 2022).

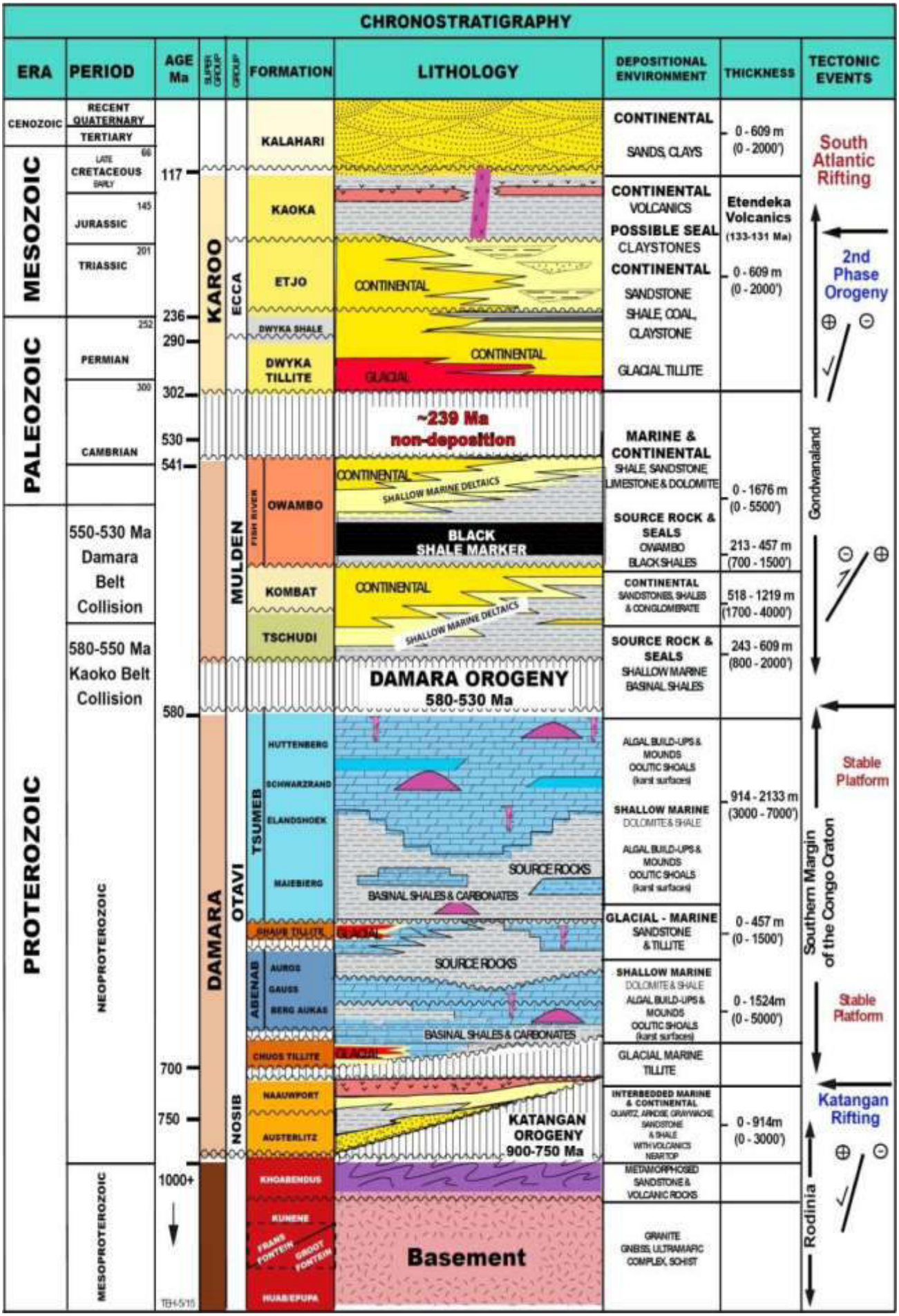


Figure 5.16: Stratigraphy column of the Owambo basin comprising rocks from Pre-Cambrian times until the Tertiary cover of the Kalahari Sands Formation with a total thickness up to 8000m. The carbonates of the Otavi Group represent the main petroleum exploration target (Source: MEL, 2022).

5.5.2 Groundwater Resources

5.5.2.1 Regional Overview

PEL 93 and the AOI falls within the Cuvelai drainage system which flow from Angola highland area, predominantly from Changongo, in Angola's southern Cunene province and through areas downstream to lake Oponono and Ekuma River and eventually to Etosha Pan through ephemeral channels (Iishana) originating from Angola (BGR-DWAF, 1999). The annually flooded Cuvelai drainage system form part of the greater Kalahari Basin which is subdivided in four main Basins namely: Zambezi Kwando Linyandi; Cuvelai-Etosha; Eiseb-Epukiro and Kavango-Omatako (BGR-DWAF, 1999).

5.5.2.2 Hydrogeological Settings of PEL 93

Various sediments of the Kalahari Group cover much for PEL 93 inclusive the AOI targeted for the proposed 2D seismic survey operations (Figs. 5.15 and 5.16). According to BGR-DWAF, (1999) and (2010), the geology of the Cuvelai drainage system comprises the Kalahari Group on top followed by the Karoo and Damara Sequences and Grootfontein Basement Complex at the bottom.

The Kalahari Group is important groundwater system in area and the upper most formation in Kalahari is the Andoni Formation which consists of semi-consolidated sand that overlies the Olukonda Formation characterised by a green to beige-white and brown colours (Fig. 5.16 and BGR-DWAF, 1999). Below Olukonda Formation is the Beiseb Formation of Eocene age, which consists of brown and grey stone and/or mud that reaches the maximum thickness of 30m (Fig. 5.16 and BGR-DWAF, 1999).

The bottom most formation is the Ombalantu Formation which consists of red beds i.e., conglomerate, shale, and sand stones. The surface limestones southern and western margin of the Cuvelai Etosha Basin (CEB) are sedimentary evaporitic limestones also known as Etosha Limestone Member (Fig. 5.16, Dierkies, 1996 and BGR-DWAF, 1999).

5.5.2.3 Aquifers of the Etosha Cuvelai Basin and PEL 93

The Cuvelai Etosha Basin (CEB) is made up of six (6) aquifers namely: Otavi Dolomite Aquifer (DO) located on the western and southern rim, followed in the north by the Etosha Limestone Aquifer (KEL), the Oshivelo Multi-layered Aquifer (KOV) in the eastern area, the Ohangwena Multi-layered Aquifer (KOH) in the north-eastern parts, the Oshana Multi-layered Aquifer (KOS) covering the area of the Cuvelai drainage system and the Omusati Multi-zoned Aquifer (KOM) situated in the west adjacent to the KOS (Fig. 5.17, BGR-DWAF., 2006, 1999, 2010, and Raison, 2011).

According to Fig. 5.17, the proposed 2D seismic survey operations cover the Etosha Limestone Aquifer (KEL), the Oshivelo Multi-layered Aquifer (KOV) and the Ohangwena Multi-layered Aquifer (KOH). Fig. 5.17 shows the type of rocks, general water depth, quality, and yield for each of the six (6) Etosha Cuvelai Basins including the three (3) Basins covered by the proposed 2D seismic survey operations.

5.5.2.4 Groundwater of Depth, Flow and Recharge

The deepest groundwater is in the northeast where most boreholes are deeper than 100 metres (Figs. 5.17 and 5.18). Water levels in the south and west of the Cuvelai Etosha Basin may be as deep, but there is greater variation from one local area to another (BGR-DWAF., 2006, 1999, 2010, and Raison, 2011). All groundwater flows towards the centre of the Basin. In the south and west, the flows are from the high-lying areas along the margins towards and below Etosha Pan (Figs. 5.19 and 5.20).

Flows of groundwater from the north into the centre are due to the higher elevations along the northern border and in Angola. The altitude of the groundwater (called the piezometric level) provides information on the direction of flow beneath the ground. Just as on the surface, water at higher altitudes flows to lower levels.

The Otavi Mountains, located to the south of the project area, are considered the most important groundwater recharge area in northern Namibia (BGR-DWAF., 2006, 1999, 2010, and Raison, 2011).

Groundwater recharged in the fractured dolomites of the Damara Sequence, which form the southern and western rim of the Cuvelai Etosha Basin, flows north- and eastwards and feeds the aquifer system of the Karoo and Kalahari sequences.

However, a major part of this north/eastbound groundwater flow is shallow, and discharges through numerous springs along the southern margin of the Etosha Pan, where it rapidly evaporates. A deep-seated multi-layered Kalahari Aquifer is recharged in Angola and groundwater flows in a southern direction towards the Etosha Pan and the Okavango River.

A shallow Kalahari Aquifer (formerly described as the brine lake area) superimposes both previously described aquifer systems in the central part of the Cuvelai Etosha Basin. The mainly saline groundwater originates from regular floods in the Cuvelai drainage, which has its headwaters in central Angola.

5.5.2.5 Groundwater Quality and Vulnerability

According to BGR-DWAF., (2010), the best borehole water within the Cuvelai Etosha Basin is in the eastern and far western areas and south and east of Etosha Pan. By contrast, water of poorest quality is in the central areas of the Basin which is where the great majority of people live. However, most of these people use piped water or fresh water from shallow hand-dug wells.

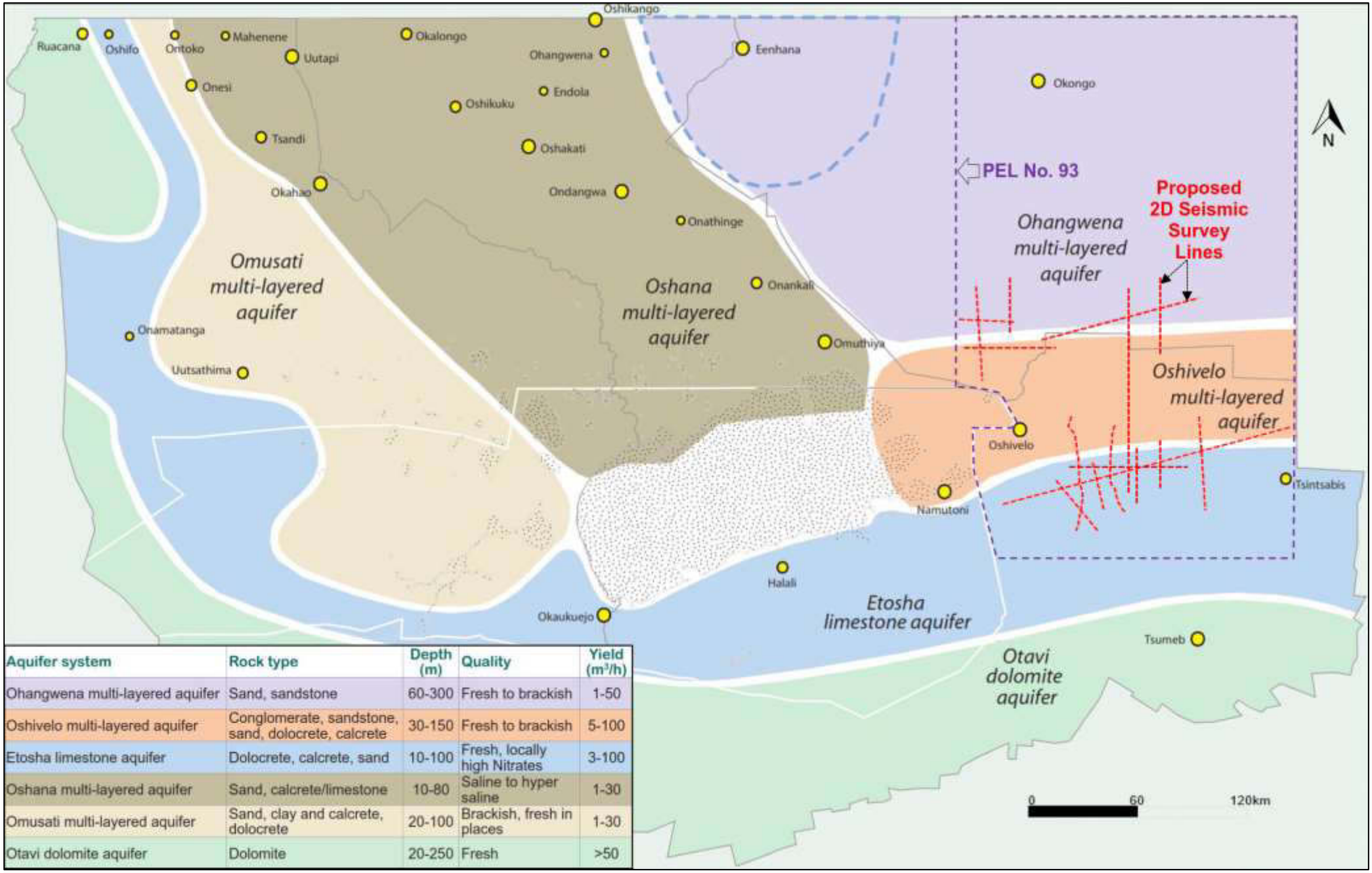
Figs. 5.21 and 5.22 show the chemical properties of deep water pumped from boreholes. People may suffer detrimental effects from high concentrations of fluorides (which affect teeth and the development of children's' bones), sulphates (act as a laxative) and nitrates (affect oxygen transport in the body) (Figs. 5.21 and 5.22).

Etosha Limestone Aquifer (KEL), the Oshivelo Multi-layered Aquifer (KOV) and the Ohangwena Multi-layered Aquifer (KOH) are three aquifers covered by the proposed 2D seismic survey. The three-aquifers supply water to the local communities and are all vulnerable to various humane related activities. The proposed 2D seismic survey will not threaten groundwater resources. Data from the proposed 2D seismic survey will provide greater undertaking to the local groundwater resources around Oshivelo.

As shown in Figs. 5.23 and 5.24, some of the water supply schemes found in the AOI are situated close to the proposed 2D seismic survey lines. Appropriate buffers will be provided around each of the water supply infrastructures situated along the proposed survey lines.

5.5.2.6 Groundwater Recommendations

It is hereby recommended that a hydrocensus survey be undertaken prior to the implementation of the proposed project activities to have accurate locations of water wells and boreholes along the proposed 2D seismic survey lines. Based on the outcomes of the hydrocensus survey, accurate offset/ setback distances shall be applied around each of the water wells and boreholes as well as associated water infrastructure situated along the proposed seismic survey lines.



Aquifer system	Rock type	Depth (m)	Quality	Yield (m^3/h)
Ohangwena multi-layered aquifer	Sand, sandstone	60-300	Fresh to brackish	1-50
Oshivelo multi-layered aquifer	Conglomerate, sandstone, sand, dolocrete, calcrete	30-150	Fresh to brackish	5-100
Etosha limestone aquifer	Dolocrete, calcrete, sand	10-100	Fresh, locally high Nitrates	3-100
Oshana multi-layered aquifer	Sand, calcrete/limestone	10-80	Saline to hyper saline	1-30
Omusati multi-layered aquifer	Sand, clay and calcrete, dolocrete	20-100	Brackish, fresh in places	1-30
Otavi dolomite aquifer	Dolomite	20-250	Fresh	>50

Figure 5.17: The Etosha Cuvelai Basin aquifers with respect to the proposed 2D seismic survey lines in PEL 93 (Base map Source and modified from: Raison, 2011, www.bgr.bund.de).

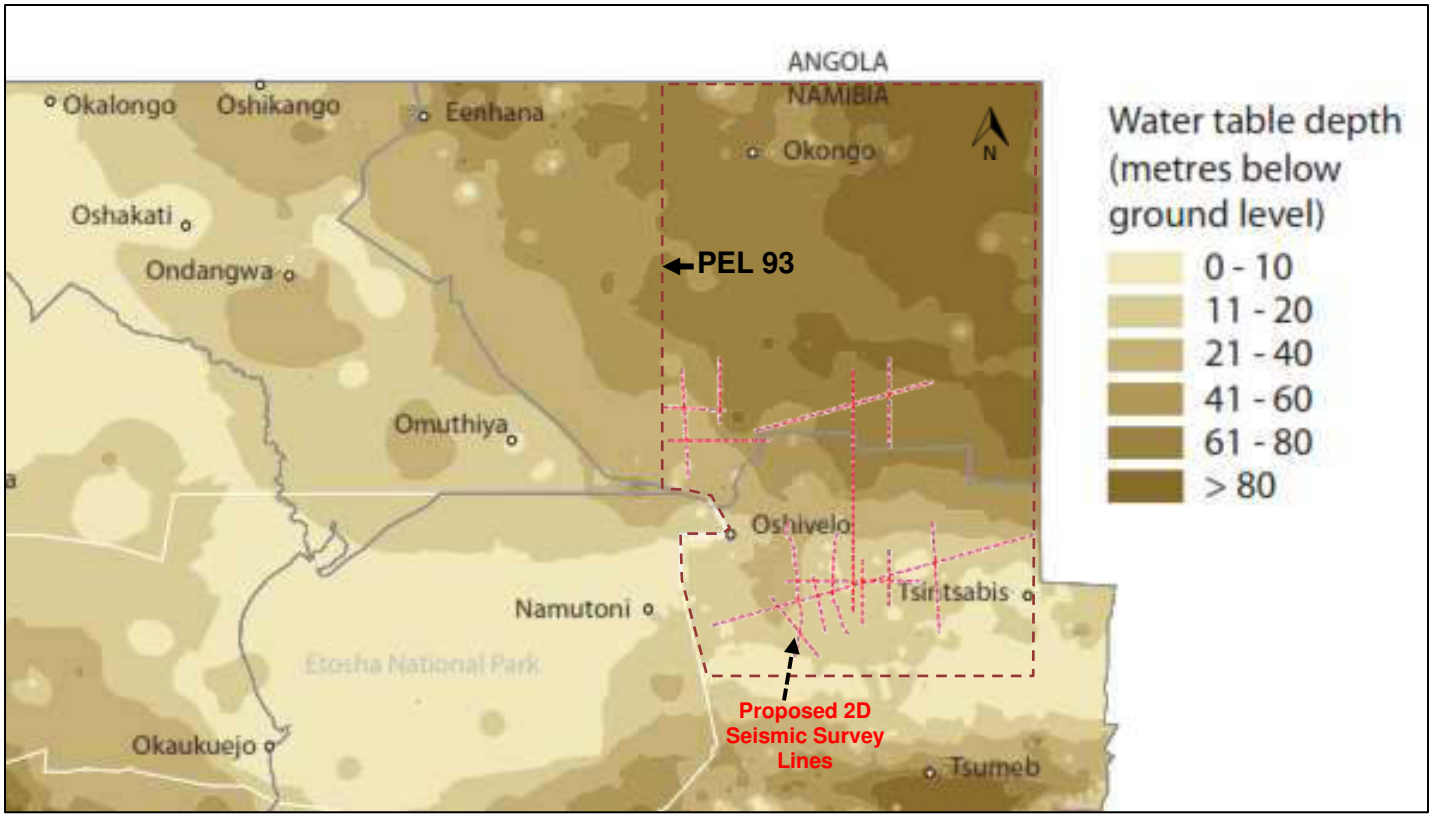


Figure 5.18: Water table depth around the Etosha Cuvelai Basin aquifers with respect to the proposed 2D seismic survey lines in PEL 93 (Base map Source and modified from: Raison, 2011, www.bgr.bund.de).

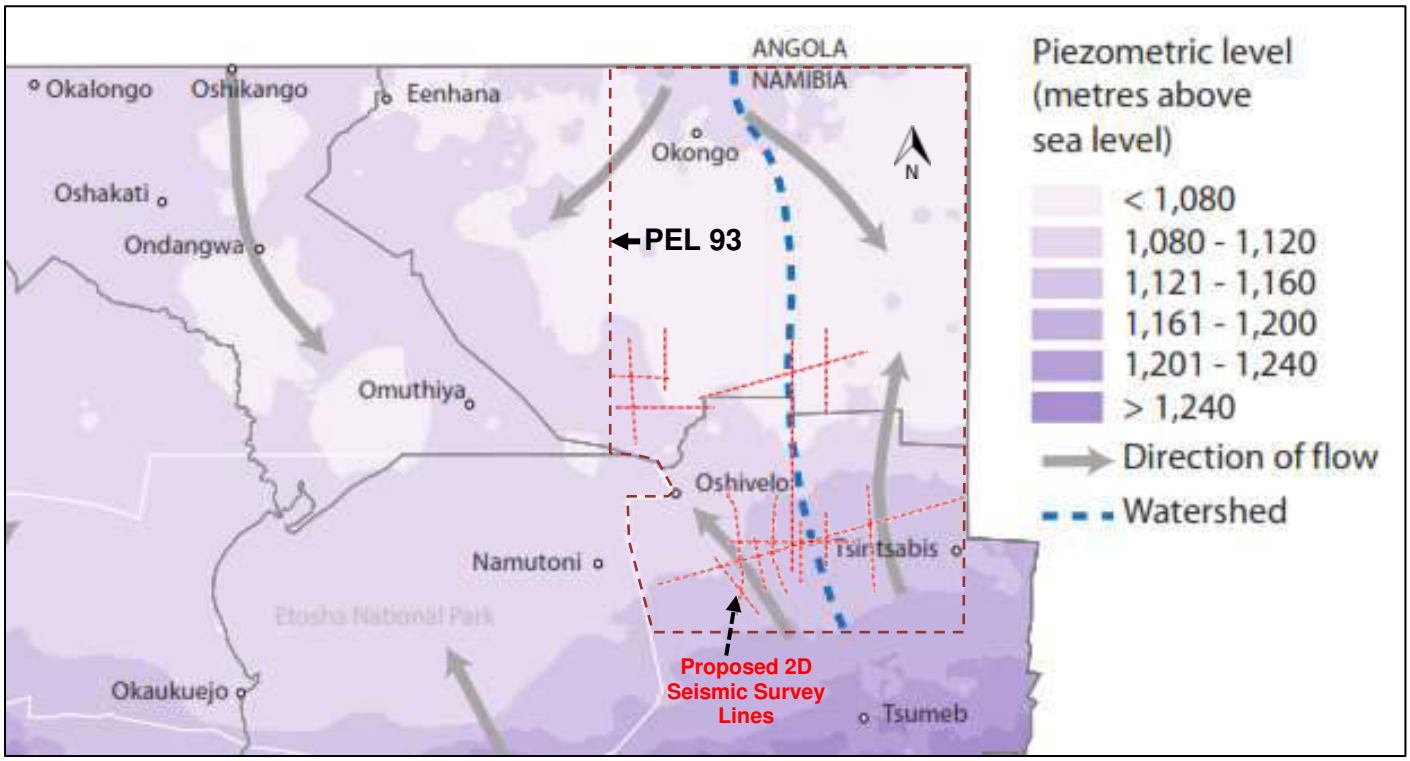


Figure 5.19: Piezometric levels around the Etosha Cuvelai Basin aquifers with respect to the proposed 2D seismic survey lines in PEL 93 (Base map Source and modified from: Raison, 2011, www.bgr.bund.de).

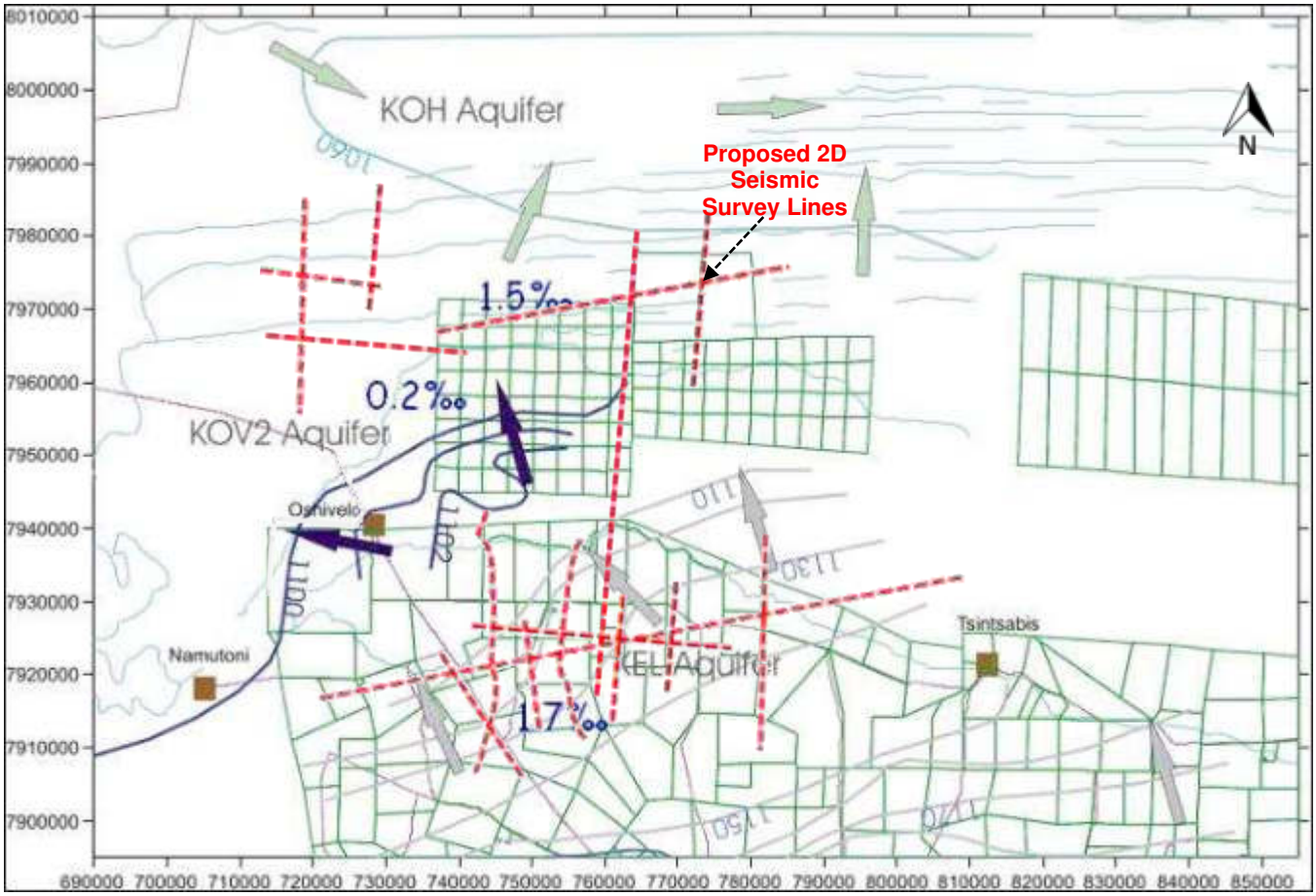


Figure 5.20: Groundwater flow pattern and hydraulic gradient around Oshivelo Etosha with respect to the proposed 2D seismic survey lines in PEL 93 (Base map Source and modified from www.bgr.bund.de).

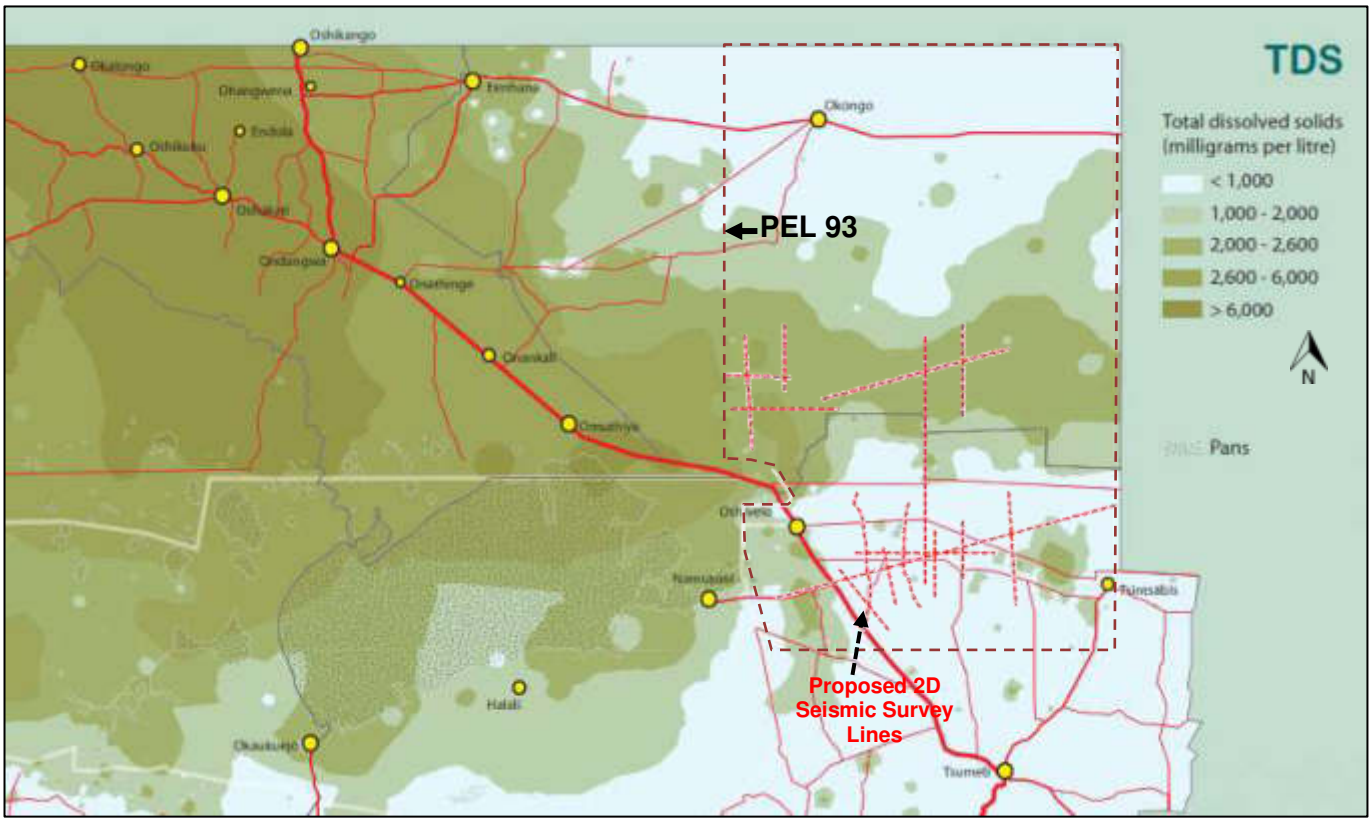


Figure 5.21: Groundwater quality (Total Dissolved Solids-TDS around the Etosha Cuvelai Basin aquifers with respect to the proposed 2D seismic survey lines in PEL 93 (Base map Source and modified from: Raison, 2011, www.bgr.bund.de).

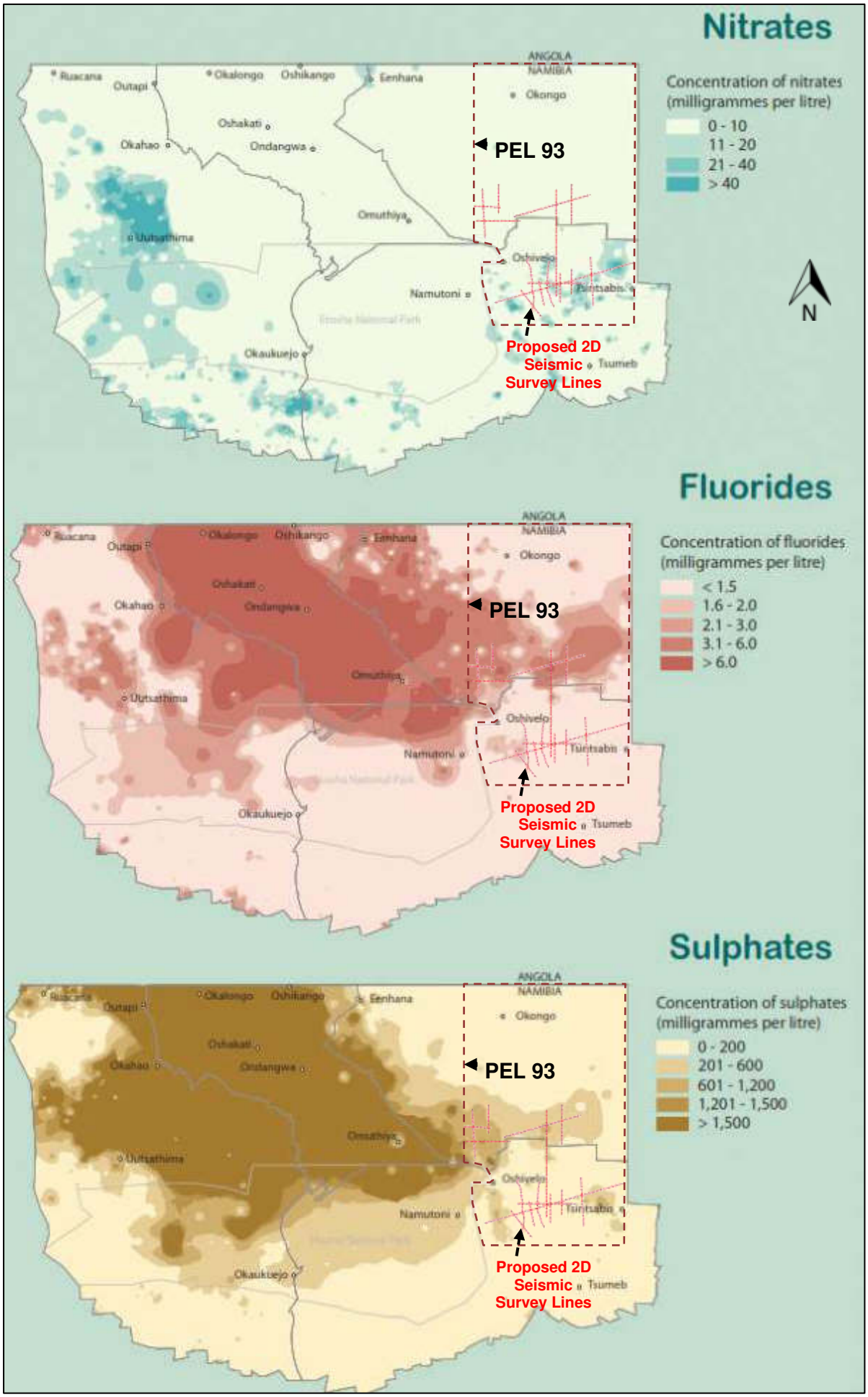


Figure 5.22: Groundwater quality (sulphates, fluorides, and nitrates), around the Etosha Cuvelai Basin aquifers with respect to the proposed 2D seismic survey lines in PEL 93 (Base map Source and modified from: Raison, 2011, www.bgr.bund.de).

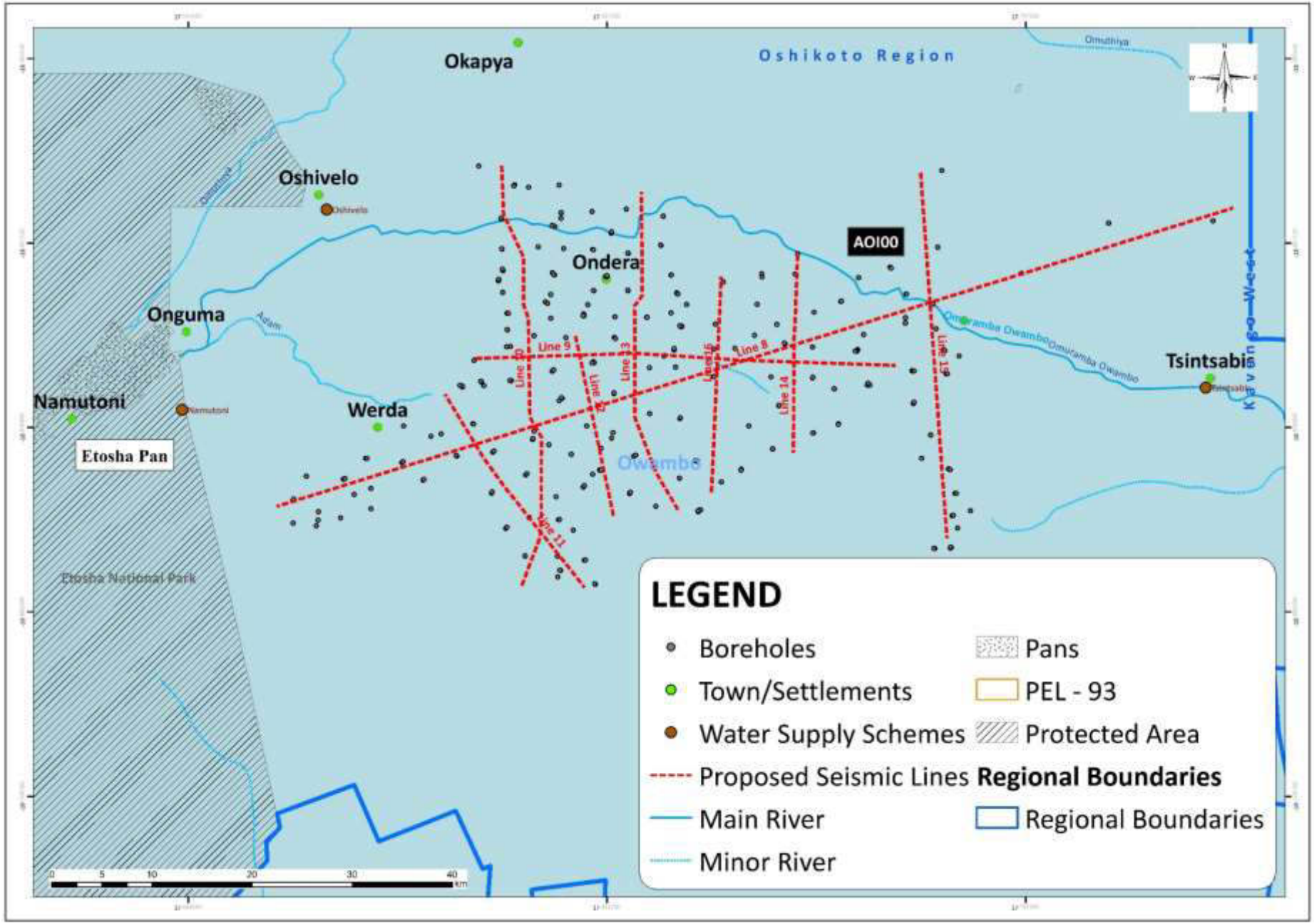


Figure 5.23: Water supply infrastructure with respect to the proposed 2D seismic survey lines around the AOI00. Appropriate buffers shall be provided around each of the water supply infrastructures situated along the proposed survey lines.

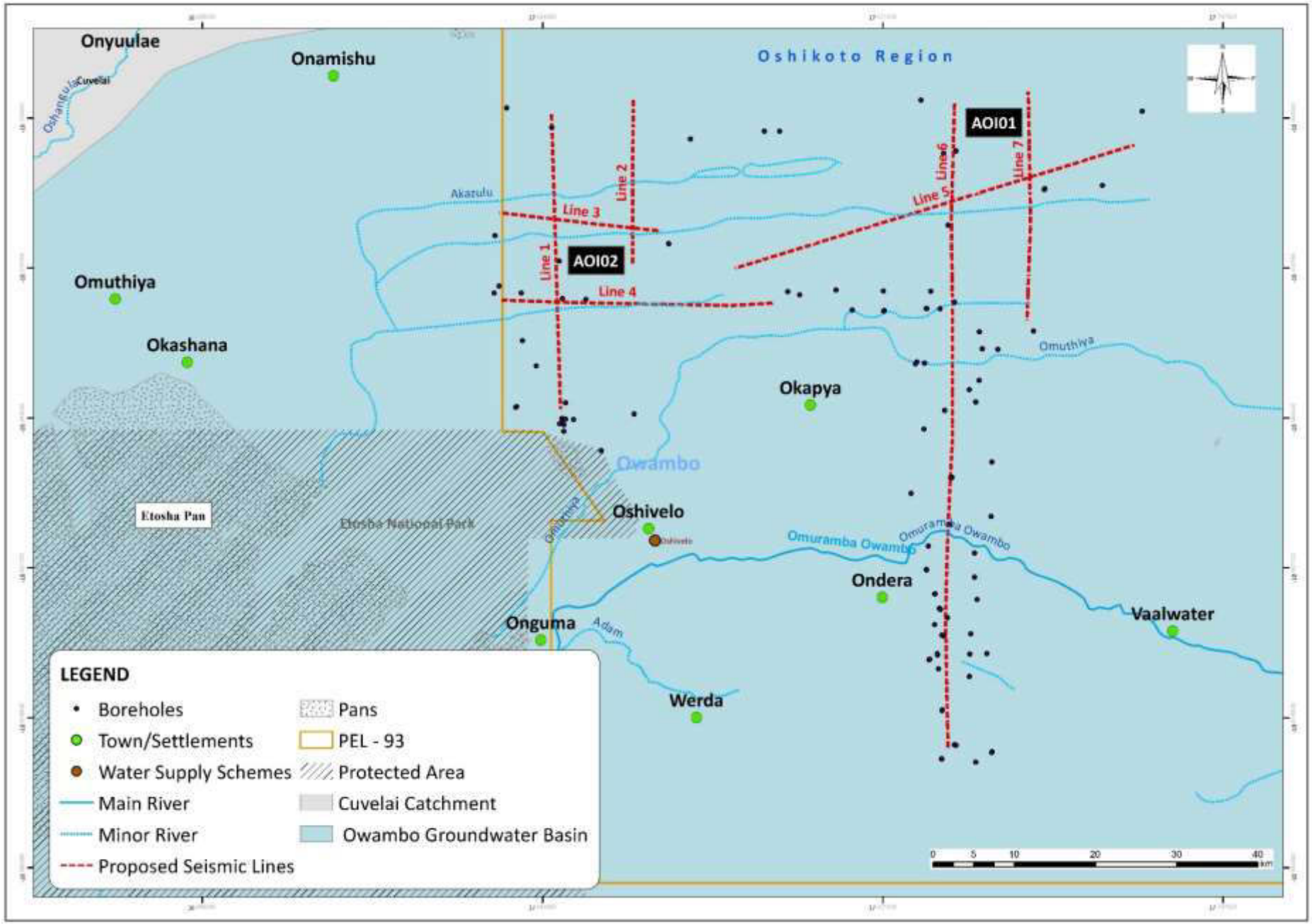


Figure 5.24: Water supply infrastructure with respect to the proposed 2D seismic survey lines around the AOI01 and AOI02. Appropriate buffers shall be provided around each of the water supply infrastructures situated along the proposed survey lines.

5.6 Historical and Archaeological Resources

5.6.1 Overview

A specialist assessment on the historical and archaeological resources covering the proposed 2D seismic survey areas of interest in PEL No. 93 was conducted (Annex 4). The assessment covered desktop studies and field-based survey of the project area.

5.6.2 Heritage Settings

The central northern Namibia is one of the few areas relatively less investigated archaeologically (Kinahan 2014 cf. Kinahan 2011; Williams 1991). As far as this area is concerned, no previous detailed archaeological or cultural heritage studies were undertaken, either within or immediately outside the proposed PEL 93.

However, Wallace and Kinahan (2011) have summarized the archaeology and history of this part of Namibia adopted from (SLR report 2019:14) and outlined below:

- Prehistoric (scattered Holocene sites and mid- to late-Pleistocene stone [lithic] assemblages).
- Pre-colonial - tribal community activity in the form of settlement (secular) and ritual sites (burial and symbolic places [landscapes]).
- German colonial (German expansion into the Namibian interior, usually in the form of economic exploitation of the veld [cattle ranching] and military activity).
- British South African colonial (a consolidation and extension of previous Colonial rule through economic exploitation of the veld and military activity), and.
- Modern (Post-1950) – a consolidation of economic resources, mainly through mining and quarrying enterprises and the growth in settlement activity.

The earliest records of human occupation chronologically dating from the Middle Stone Age evidenced by extensive surface scatter of MSA artifacts such as polyhedral cores and utilized flakes (Kinahan 2014) as well as potteries fragments with a likelihood of other archaeological remains in form of burial grounds in or near old settlement in unmarked graves, sacred sites, ruins suspected near the alignment ends on north bank of Omuramba Owambo near Oshivelo where a large population of Hai||Om lives today in the Mangetti West area populated mainly by //Khausis San (Annex 4, Fig. 5).

This was confirmed through interviews conducted among the larger settlements of San communities in Hedwigslust Farm 307 (Ombili Foundation) and Tsintsabis settlement (Annex 4). There is no physical evidence to establish when the present day San tribes populated this area but oral records indicate that they have lived in at least parts of this area of Namibia for at least 500 years (Kinahan 2014).

Physical archaeological evidence of these communities remains difficult to locate because of increased traditional settlements by different ethnic groups, changes in land use system and varieties of cultural practices which will likely prevent the archaeological preservation attributed to Hunter Gatherers (Annex 4).

5.6.3 Findings and Recommendations

The field survey has located a number of historic and ethnographic sites found within the proposed area for 2D seismic survey considered to be significant and sensitive (Tables 5.2 -54). Such sites require special mitigation measures including the application of the appropriate offset distance as may be applicable. Sensitive heritage localities within 1km of the proposed 2D seismic survey and within PEL 93 have been identified as listed in Table 5.4.

The typology of these resources is both ethnographical and historical. It is recommended that the project adopt the recommended mitigation measures as detailed in Annex 4 and the EMP Reports. Appropriate offset distance from the no-go areas and heritage localities situated about 1km from the proposed 2D seismic survey lines shall be adopted at all times (Table 3.1). Namibia does not have specific regulations or guidelines on setback distances from specified infrastructures or sensitive environment with respect to onshore seismic survey operations.

As international operator, MEL shall adopt the Alberta Government of Canada Distance Requirements Exploration Directive 2006-15 as shown in Table 3.1 of this report and with additional guidelines as provided by the International Association of Geophysical Contractors (IAGC). According to the recommended setback distance of 50m (Table 3.1) from the sensitive heritage localities, even the 1km nearest sites are still far away from the planned 2D seismic survey lines operations and are unlikely to be negatively impacted by the proposed once-off drive through 2D seismic survey operations.

Table 5.2: List of registered and known heritage sites within ±40km radius of PEL 93 area (Annex 4).

Number	Site name	GPS Coordinates	Description	Vulnerability
142	Lake Otjikoto	19°11'42.35"S / 17°32'59.27"E	Repository of WWI ammunition by German Forces & Sacred site for pre-colonial population.	No, site located over 30km from PEL 93
013/1951	Baobab Tree (No. 1063)	18°53'10.54"S/ 18°19'37.84"E	Sacred site associated with San tradition.	No, site located over 50km from PEL 93
OSHI 64	Ndonga Trading Tree	19º1'44.53" S 17º33'02.90" E	Ndonga traders would walk a distance of around 280km to Otjikoto Lake and then light a fire next to the tree to inform the Hai//kom of their arrival. They would then trade for copper ore and ostrich eggs. The copper ore would be smelted near the tree (as it was heavy to carry) and copper rods produced. Thick ones that would be used to make anklets and more narrow ones for arrow and spearheads cast. The rods would then be carried back to Ondonga in baskets.	No, site located 18km from PEL 93
OSHI 057	Lake Guinas	19°13'58.25"S/ 17°21'9.61"E	Natural Site	No, site located over 3okm from PEL 93
OSHI 2	Onyayia	18º21'52"S/ 16º35'44"E	Area inhabited by San Communities who worked as messengers for Ndonga King.	No, site located 40km from PEL 93
OSHI 15 /1950	Namutoni Fort	18°48'34.29"S/ 16°56'24.52"E	Fort Namutoni presents a romantic image of German colonial power, even though this is not the original fort that was involved in the Battle of Namutoni in January, 1904 (which was abandoned by the Germans and then destroyed by the Ndonga forces).	No, site located 18km from PEL 93

Table 5.3: List of potential archaeological sites registered in surrounding areas of Oshivelo and within the PEL 93 area ±14km radius of 2D Seismic Survey Line (Annex 4).

Site No	GPS Coordinates	Name	Description	Geology	Vulnerability	Recommendation
1	18˚37'2.24"S 17˚38'11.50"E	Old Farm/Settlement	Porous aquifer in Kalahari sandveld	Quaternary and Tertiary periods	7km from 2D Seismic Line	Detailed assessment required
2	18°36'54.04"S17°37' 55.98"E	Lines of trees	Porous aquifer in Kalahari sandveld	Quaternary and Tertiary periods	7km from 2D Seismic Line	Detailed assessment required
3	18°37'54.53"S 17°23'42.05"E	Old Farm / Settlement	Porous aquifer in Kalahari sandveld	Quaternary and Tertiary periods	6km from 2D Seismic Line	Detailed assessment required
4	18°34'7.25"S/17°12' 29.71"E	Old Settlement	Porous aquifer in Kalahari sandveld	Triassic	12km from 2D Seismic Line	Detailed assessment required
5	18°32'12.08"S/17°1 4'18.27"E	Old Settlement	Porous aquifer in Kalahari sandveld	Triassic	10km from 2D Seismic Line	Detailed assessment required
6	18°34'28.54"S/ 17°18'20.75"E	Old Settlement	Porous aquifer in Kalahari sandveld	Quaternary and Tertiary periods	10km from 2D Seismic Line	Detailed assessment required (No-Go)
7	18°31'57.29"S/17°1 4'30.88"E	Old Settlement	Porous aquifer in Kalahari sandveld	Quaternary and Tertiary periods	10km from 2D Seismic Line	Detailed assessment required (No-Go)
8	18°30'58.80"S/17° 9'0.54"E	Old Settlement	Porous aquifer in Kalahari sandveld	Triassic	9km from 2D Seismic Line	Detailed assessment required (No-Go)
9	18°29'29.91"S/17°1 3'38.09"E	Old Settlement	Porous aquifer in Kalahari sandveld	Triassic	14km from 2D Seismic Line	Detailed assessment required
10	18°28'25.11"S/17°1 7'15.43"E	Old Settlement	Porous aquifer in Kalahari sandveld	Quaternary and Tertiary periods	12km from 2D Seismic Line	Detailed assessment required
11	18°29'55.89"S/ 17°15'31.10"E	Old Settlement	Porous aquifer in Kalahari sandveld	Quaternary and Tertiary periods	11km from 2D Seismic Line	Detailed assessment required
12	18°30'5.83"S/17°25' 2.95"E	Old Settlement	Porous aquifer in Kalahari sandveld	Quaternary and Tertiary periods	7km from 2D Seismic Line	Detailed assessment required
13	18°26'51.69"S/17°2 5'48.29"E	Old Settlement	Porous aquifer in Kalahari sandveld	Quaternary and Tertiary periods	7km from 2D Seismic Line	Detailed assessment required

Table 5.4: Present heritage sites/areas within 1km radius of the proposed 2D seismic survey lines (Annex 4).

GPS Coordinates	Name /Area	Description	Recommendation
18°30'38.11"S 17° 4'27.65"E	King Kauluma village	The site was founded in 1990 shortly after independence after the King of Ondonga, King Immanuel Kauluma gave farm land to the Namibian returnee who initially based at the former army base used by SADF soldiers. Due to unemployment the site became small projects to help returnees who had a bakery and a small designated agriculture (Field Crop).	Highly sensitive No Go/ Avoid
18°29'59.14"S 17° 3'55.00"E	King Kauluma Cemetery	Burial ground for Namibian heroes and heroines	Highly sensitive No Go/ Avoid
18°29'20.67"S 17° 3'51.01"E	King Kauluma School	Former South West Africa Territorial Force (SWATF) Military Base. The entire area is still suspected to have unexploded ammunition including those recently de-mined in the school. Otherwise, further de-mining exercise is required. The area might also have buried historical ammunition including graves.	Highly sensitive and dangerous No Go/ Avoid Detailed Assessment
18°12'7.32"S 17° 8'32.09"E Or 18°11'60.00"S 17°12'60.00"E	Akazulu / Akadhulu	Sacred site / intermittent stream	Highly sensitive No Go/ Avoid
18°46'11.25"S 17°57'59.37"E	Tsintsabis Settlement	Former South West Africa Territorial Force (SWATF) Military Base. The entire settlement is still suspected to have unexploded ammunition including those recently de-mined. The settlement (30km radius) is also suspected to have burial grounds and old settlements for the San people.	Highly sensitive No Go/ Avoid Detailed Assessment
18.643720”S 17.177336”E	Alignment of Omuramba/ Owambo banks between Oshivelo and Tsintsabis	Likelihood of archaeological remains in form of burial grounds in or near old settlement in unmarked graves, sacred sites, ruins where a large population of Hai||om lives today and near Mangetti West area populated mainly by //Khausis San	Highly sensitive Detailed Assessment

5.7 Public and Stakeholder Consultation Process

5.7.1 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 public, stakeholders and community regulatory consultations were undertaken during the months of February and March 2022 with respect to the proposed 2D seismic survey operations in PEL 93.

The consultation process covered the following key activities (Annex 5):

(i) Public notices were published in the local newspapers.

(ii) Copies of the Draft Scoping Report was sent to all the land owners and Interested and Affected Parties (I&APs) within the project area based on the Postal Addresses obtained from the Deed Office, Surveyor General Office, the Ministry of Agriculture, Water and Land Reform, and.

(iii) Five (5) public, stakeholder and community meetings were organised in Oshikoto Region and minutes of the meetings are attached in Annex 5.

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 was prepared and used for project registration with the Environmental Commissioner in the Ministry of Environment, Forestry and Tourism.

5.7.2 Public Notices Published in the Local Newspapers

The following is the summary of the public notices that were published in the local newspapers during the months of February and March 2022 (Figs. 5.25-5.29 and Annex 5).

(i) New Era Newspaper dated Monday, 21st February 2022 (Fig. 5.25).

(ii) The Market Watch insert in the Allgemeine Zeitung newspaper dated 11th – 17th March 2022 (Fig. 5.25).

(iii) The Market Watch insert in the Republikein newspaper dated 11th – 17th March 2022 (Fig. 5.27).

(iv) The Market Watch insert in the Republikein newspaper dated 11th – 17th March 2022, (Fig. 5.28), and.

(v) The Confidente Newspaper dated Wednesday 2nd March 2022 (Fig. 5.29).

5.7.3 Communications Send to Interested and Affected Parties (I&APs)

Formal letters were sent to all regional institutional stakeholder such as the Oshikoto Regional Council and all the Oshikoto Constituency Councillors, the Ondonga Traditional Authority (King of Ondonga, King Fillemon Shuumbwa) and communal and commercial land owner / Interested and Affected Parties (I&APs) where the AOI00, AOI01 and AOI02 are situated (Fig. 5.30 and Annex 5).

Copies of all the communications send to and received from I&APs including submissions made by the stakeholders are attached to this report in Annex 5.

Monday 21 February 2022 | NEW ERA

Liswani: Policies should impact lives of women

■ Loide Jason

Katrina Liswani believes the advancement of women should not be seen as undermining or being done at the expense of men.

The 68-year-old, who eyes the position of Swapo Party Women's Council (SPWC) secretary, said she will drive policy directives that will have an impact on the lives of women, including girls, to be part of the national agenda.

Liswani was born in 1954 at the Okalumbu village in Onyaanya constituency of the Oshikoto region. The mother of two sons and two daughters says she is a tested and educated cadre, who understands the socio-economic situation of women at all levels, including those with disabilities.

"We need a leader with zeal and capacity to drive policy directives that have long-term impacts on the lives of our women, including girls, to find their space in society and being part of the national agenda. I possess all that, and that makes me the right candidate for this position. I love our country, I love our party and will work hard to unite our people, and continue to make SPWC relevant and a force to be reckoned with," she enthused.

She has worked in the labour sphere in Namibia's civil service, the African Union Commission as well as the International Labour Organisation.

Liswani holds a Master's degree in Public Policy and Administration, a Bachelor's degree in Business Administration and several diplomas in various fields such as political, financial management, labour administration, strategic management, personnel management, employment, leadership, child labour and gender training.

"I am a founder member of the Namibia Poverty Alleviation Foundation, a foundation that was created with the sole aim of alleviating poverty and addressing socio-economic challenges faced by women and children, particularly those living with disabilities. I am a freedom fighter as I participated in the liberation struggle of our country. I left Namibia in 1974, together with my comrades to join our brothers and sisters in exile, fighting to liberate our country from the South African apartheid regime. I was repatriated in 1989 to come and take part in the first democratic elections, in which our mighty Swapo party emerged victoriously," she said.

Impact... Katrina Liswani is standing for the Swapo Party Women's Council's secretary position. Photo: Contributed

Liswani was not only part of the crop that liberated the country, but served in various positions of influence because of her qualifications, experience and patriotism.

"But all in all, I am proud that I have been part of the team responsible for labour matters, focusing on the bread-and-butter issues of our people. I have been part of the agenda to change the socio-economic status of our people, and I am proud that the development of policies that I have been part of were able to improve the living standards of our people," she observed.

She said the country must continue to do more in striking the balance in efforts to uphold gender equality.

"The advancement of women should not be seen as undermining the opposite gender, nor should it be done at the expense of men. Women must not be undermined, but should be given opportunities and platforms to exercise their abilities. It is a topic that the nation should continue discussing," the politician urged.

She added that there must be coordination among all stakeholders involved in fighting gender-based violence and determine its root causes as it is of paramount importance.

Farmers demonstrate against asparagus, weather station

■ Festus Hamalwa

On Friday, farm owners and some residents of Etunda and surrounding areas in the Omusati region held a demonstration to call for the closure of the Otjimbele asparagus operation at the Etunda green scheme.

The farmers claimed that the farm management installed a device that prevents rain, despite flash floods in the area recently.

At the centre of the storm was an automatic weather station (AWS), used for real-time information on weather at the farm level. The AWS also provides information on soil moisture and soil temperature, giving better information on irrigation requirements.

Please... Agriculture minister Calle Schlettwein told demonstrators at the Ohakweenyanga village that an automatic weather station doesn't cause drought. Photo: Festus Hamalwa

Minister of Agriculture, Water and Land Reform Calle Schlettwein said asparagus doesn't prevent rain, and it is totally illogical to say that plants influence weather patterns.

The minister reiterated that the claims are a myth and unfounded allegations, and should thus be disregarded.

He said this during the demonstration of new agriculture equipment and machinery held at Ohakweenyanga village in the Oshana region on Saturday.

Schlettwein stated that people should stop listening to misinformation.

"This weather equipment has nothing to do with changing weather patterns. There is no evidence that asparagus is changing weather. It is completely unfounded to say that the weather station and equipment is changing weather at Etunda," he explained.

The minister added that the weather stations at Etunda measure how the weather is changing, but do not change the weather.

"In fact, I wish I could give all the small farmers a small weather station so that the farmers could be aware of this equipment, the environment and those plants to have a better understanding," he said.

"We, as farmers, should know that plants need rain, and they cannot grow without water. In fact, on the asparagus plantation we irrigate, we put borehole water on the ground to let them grow," he stated.

He further emphasised that the farmers should know that the government has invested in agricultural production. Therefore, if Etunda closes down, it will simply cause poverty for more people.

Close to 800 people are employed at the Etunda project.

NBC reported that the aggrieved residents later withdrew their petition on claims about the asparagus project.

- fhamalwa@nepc.com.na

Figure 5.25: Copy of the public notice that was published in the New Era Newspaper dated Monday, 21st February 2022.

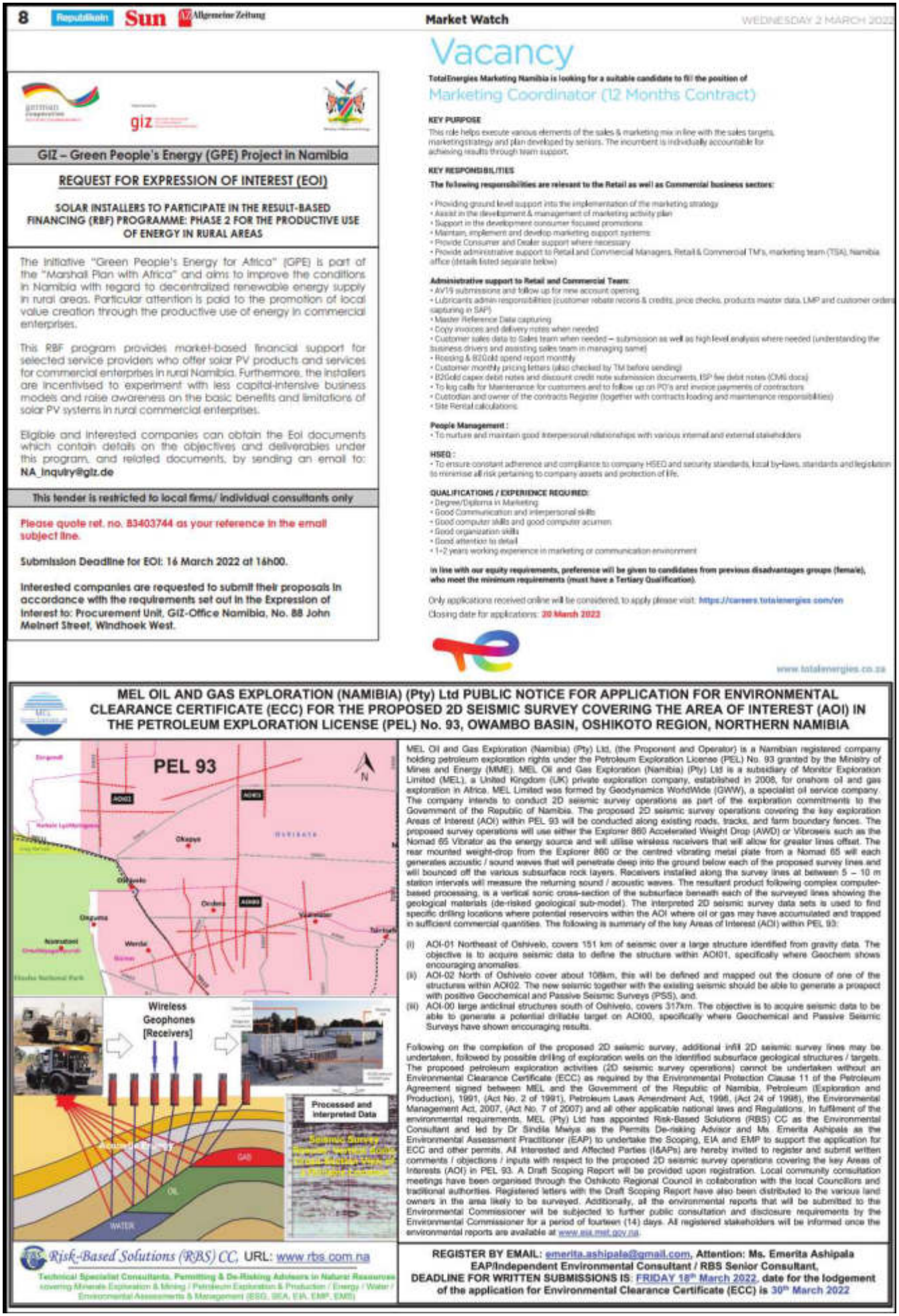
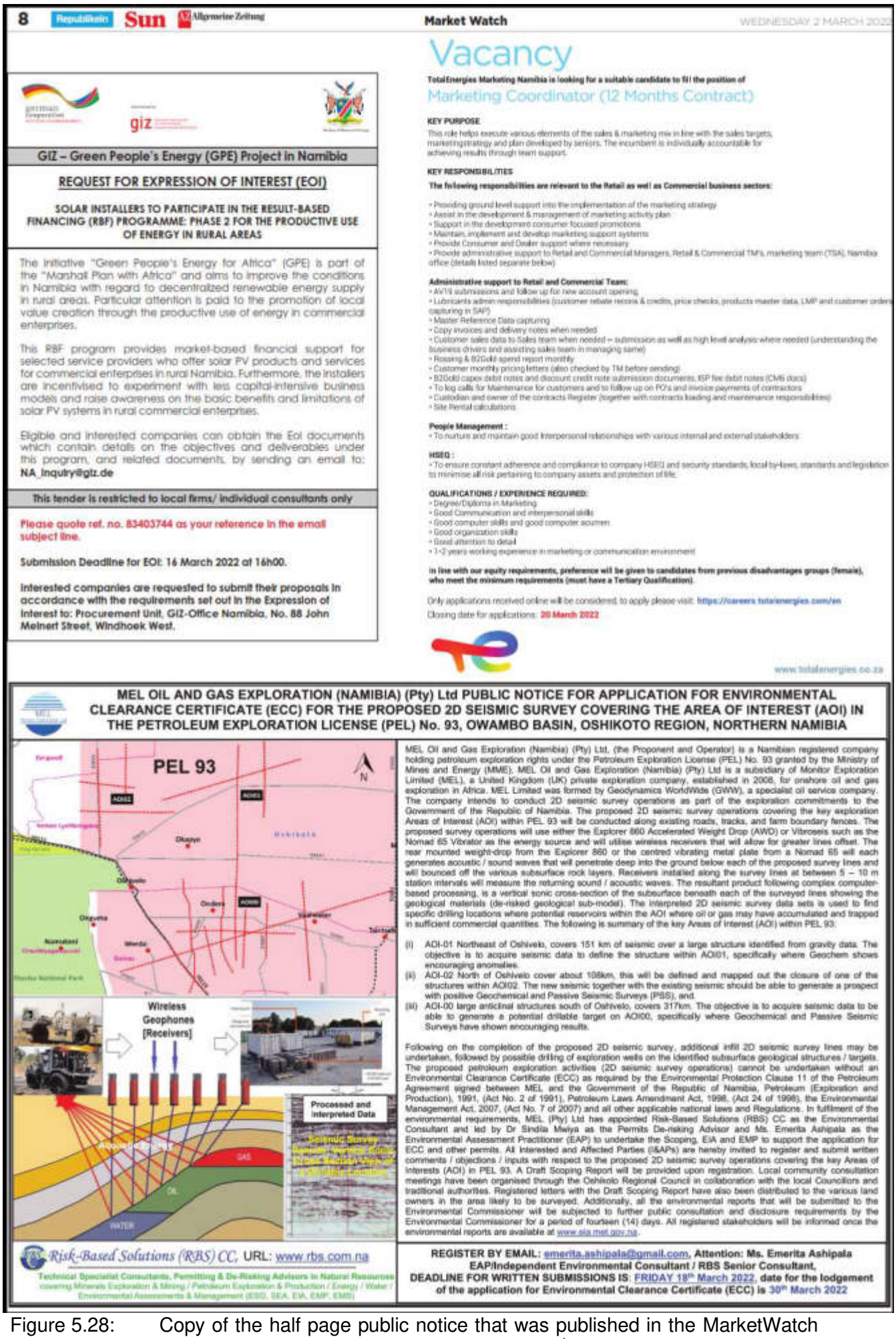


Figure 5.26: Copy of the half page public notice that was published in the MarketWatch Allgemeine Zeitung Newspaper dated Wednesday 2nd March 2022.

Figure 5.27: Copy of the half page public notice that was published in the MarketWatch Namibian Sun Newspaper dated Wednesday, 2nd March 2022.



8 Republikein Sun Allgemeine Zeitung

Market Watch WEDNESDAY 2 MARCH 2022

giz

GIZ – Green People's Energy (GPE) Project in Namibia

REQUEST FOR EXPRESSION OF INTEREST (EOI)

SOLAR INSTALLERS TO PARTICIPATE IN THE RESULT-BASED FINANCING (RBF) PROGRAMME: PHASE 2 FOR THE PRODUCTIVE USE OF ENERGY IN RURAL AREAS

The initiative "Green People's Energy for Africa" (GPE) is part of the "Marshall Plan with Africa" and aims to improve the conditions in Namibia with regard to decentralized renewable energy supply in rural areas. Particular attention is paid to the promotion of local value creation through the productive use of energy in commercial enterprises.

This RBF program provides market-based financial support for selected service providers who offer solar PV products and services for commercial enterprises in rural Namibia. Furthermore, the installers are incentivised to experiment with less capital-intensive business models and raise awareness on the basic benefits and limitations of solar PV systems in rural commercial enterprises.

Eligible and interested companies can obtain the EoI documents which contain details on the objectives and deliverables under this program, and related documents, by sending an email to: **NA_Inquiry@giz.de**

This tender is restricted to local firms/ individual consultants only

Please quote ref. no. 83403744 as your reference in the email subject line.

Submission Deadline for EOI: 16 March 2022 at 16h00.

Interested companies are requested to submit their proposals in accordance with the requirements set out in the Expression of Interest to: Procurement Unit, GIZ-Office Namibia, No. 88 John Meinert Street, Windhoek West.

Vacancy

TotalEnergies Marketing Namibia is looking for a suitable candidate to fill the position of

Marketing Coordinator (12 Months Contract)

KEY PURPOSE

This role helps execute various elements of the sales & marketing mix in line with the sales targets, marketing strategy and plan developed by seniors. The incumbent is individually accountable for achieving results through team support.

KEY RESPONSIBILITIES

The following responsibilities are relevant to the Retail as well as Commercial business sectors:

- Providing ground level support into the implementation of the marketing strategy
- Assist in the development & management of marketing activity plan
- Support in the development consumer focused promotions
- Maintain, implement and develop marketing support systems
- Provide Consumer and Dealer support where necessary
- Provide administrative support to Retail and Commercial Managers, Retail & Commercial TM's, marketing team (TSA), Namibia office (details listed separate below)

Administrative support to Retail and Commercial Team:

- AVTR submissions and follow up for new account opening
- Lubricants admin responsibilities (customer rebate recons & credits, price checks, products master data, LMP and customer orders capturing in SAP)
- Master Reference Data capturing
- Copy invoices and delivery notes when needed
- Customer sales data to Sales team when needed – submission as well as high level analysis where needed (understanding the business drivers and assisting sales team in managing same)
- Rossing & B2Gold spend report monthly
- Customer monthly pricing letters (also checked by TM before sending)
- B2Gold capex debit notes and discount credit note submission documents, ISP fee debit notes (CMS docs)
- To log calls for Maintenance for customers and to follow up on PO's and invoice payments of contractors
- Custodian and owner of the contracts Register (together with contracts loading and maintenance responsibilities)
- Site Rental calculations

People Management :

- To nurture and maintain good interpersonal relationships with various internal and external stakeholders

HSEQ :

- To ensure constant adherence and compliance to company HSEQ and security standards, local by-laws, standards and legislation to minimise all risk pertaining to company assets and protection of life.

QUALIFICATIONS / EXPERIENCE REQUIRED:

- Degree/Diploma in Marketing
- Good Communication and interpersonal skills
- Good computer skills and good computer acumen
- Good organization skills
- Good attention to detail
- 1-2 years working experience in marketing or communication environment

In line with our equity requirements, preference will be given to candidates from previous disadvantages groups (female), who meet the minimum requirements (must have a Tertiary Qualification).

Only applications received online will be considered, to apply please visit: **https://careers.totalenergies.com/en**

Closing date for applications: **20 March 2022**

www.totalenergies.co.za

MEL OIL AND GAS EXPLORATION (NAMIBIA) (Pty) Ltd PUBLIC NOTICE FOR 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. 93, OWAMBO BASIN, OSHIKOTO REGION, NORTHERN NAMIBIA

MEL Oil and Gas Exploration (Namibia) (Pty) Ltd, (the Proponent and Operator) is a Namibian registered company holding petroleum exploration rights under the Petroleum Exploration License (PEL) No. 93 granted by the Ministry of Mines and Energy (MME). MEL Oil and Gas Exploration (Namibia) (Pty) Ltd is a subsidiary of Monitor Exploration Limited (MEL), a United Kingdom (UK) private exploration company, established in 2008, for onshore oil and gas exploration in Africa. MEL Limited was formed by Geodynamics WorldWide (GWW), a specialist oil service company. The company intends to conduct 2D seismic survey operations as part of the exploration commitments to the Government of the Republic of Namibia. The proposed 2D seismic survey operations covering the key exploration Areas of Interest (AOI) within PEL 93 will be conducted along existing roads, tracks, and farm boundary fences. The proposed survey operations will use either the Explorer 860 Accelerated Weight Drop (AWD) or Vibroseis such as the Nomad 65 Vibrator as the energy source and will utilise wireless receivers that will allow for greater lines offset. The rear mounted weight-drop from the Explorer 860 or the centred vibrating metal plate from a Nomad 65 will each generates acoustic / sound waves that will penetrate deep into the ground below each of the proposed survey lines and will bounced off the various subsurface rock layers. Receivers installed along the survey lines at between 5 – 10 m station intervals will measure the returning sound / acoustic waves. The resultant product following complex computer-based processing, is a vertical sonic cross-section of the subsurface beneath each of the surveyed lines showing the geological materials (de-risked geological sub-model). The interpreted 2D seismic survey data sets is used to find specific drilling locations where potential reservoirs within the AOI where oil or gas may have accumulated and trapped in sufficient commercial quantities. The following is summary of the key Areas of Interest (AOI) within PEL 93:

(i) AOI-01 Northeast of Oshivelo, covers 151 km of seismic over a large structure identified from gravity data. The objective is to acquire seismic data to define the structure within AOI01, specifically where Geochem shows encouraging anomalies.
(ii) AOI-02 North of Oshivelo cover about 108km, this will be defined and mapped out the closure of one of the structures within AOI02. The new seismic together with the existing seismic should be able to generate a prospect with positive Geochemical and Passive Seismic Surveys (PSS), and.
(iii) AOI-00 large anticlinal structures south of Oshivelo, covers 317km. The objective is to acquire seismic data to be able to generate a potential drillable target on AOI00, specifically where Geochemical and Passive Seismic Surveys have shown encouraging results.

Following on the completion of the proposed 2D seismic survey, additional infill 2D seismic survey lines may be undertaken, followed by possible drilling of exploration wells on the identified subsurface geological structures / targets. The proposed petroleum exploration activities (2D seismic survey operations) cannot be undertaken without an Environmental Clearance Certificate (ECC) as required by the Environmental Protection Clause 11 of the Petroleum Agreement signed between MEL 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. In fulfilment of the environmental requirements, MEL (Pty) Ltd has appointed Risk-Based Solutions (RBS) CC as the Environmental Consultant and led by Dr Sindila Mwiya as the Permits De-risking Advisor and Ms. Emerita Ashipala as the Environmental Assessment Practitioner (EAP) to undertake the Scoping, EIA and EMP to support the application for ECC and other permits. All Interested and Affected Parties (I&APs) are hereby invited to register and submit written comments / objections / inputs with respect to the proposed 2D seismic survey operations covering the key Areas of Interests (AOI) in PEL 93. A Draft Scoping Report will be provided upon registration. Local community consultation meetings have been organised through the Oshikoto Regional Council in collaboration with the local Councillors and traditional authorities. Registered letters with the Draft Scoping Report have also been distributed to the various land owners in the area likely to be surveyed. Additionally, all the environmental reports that will be submitted to the Environmental Commissioner will be subjected to further public consultation and disclosure requirements 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.

Risk-Based Solutions (RBS) CC, URL: www.rbs.com.na

Technical Specialist Consultants, Permitting & De-Risking Advisors to Natural Resources covering Minerals Exploration & Mining / Petroleum Exploration & Production / Energy / Water / Environmental Assessments & Management (ESG, SEA, EIA, EMP, EMS)

REGISTER BY EMAIL: emerita.ashipala@gmail.com, Attention: Ms. Emerita Ashipala EAP/Independent Environmental Consultant / RBS Senior Consultant,
DEADLINE FOR WRITTEN SUBMISSIONS IS: FRIDAY 18th March 2022, date for the lodgement of the application for Environmental Clearance Certificate (ECC) is 30th March 2022

Figure 5.28: Copy of the half page public notice that was published in the MarketWatch Republikein Newspaper dated Wednesday, 2nd March 2022.

Lower output expected for Otjikoto

• BY HILARY MARE

OTJIKOTO'S gold production is budgeted to be lower in 2022 (compared to Otjikoto's record annual gold production of 197 573 ounces in 2021) as lower grade ore is anticipated to be processed in 2022 following the planned completion of mining at the higher grade Wolfshag Pit Phase 3 in the first quarter of 2022.

The Otjikoto Mine is expected to produce between 175 000 and 185 000 ounces of gold in 2022.

In the first half of 2022, processed ore is expected to be sourced from Phase 3 of the Wolfshag Pit (scheduled to be completed in the first quarter of 2022) and Phase 3 of the Otjikoto Pit, supplemented by medium and high-grade ore stockpiles, expected to result in an average head grade of approximately 1.26 g/t.

In the second half of 2022, head grade is expected to increase and average approximately 2.10 g/t, when mining is scheduled to reach the higher-grade portions of Phase 3 of the Otjikoto Pit and high-grade ore production ramps up at the Wolfshag underground mine.

"As a result of this timing of high-grade ore mining, Otjikoto's gold production is expected

to be significantly weighted to the second half of 2022. For the first half of 2022, Otjikoto's gold production is expected to be between 65 000 and 70 000 ounces, which is expected to increase significantly to between 110 000 and 115 000 ounces during the second half of 2022," Clive Johnson, president and chief executive officer of the mine said.

The Otjikoto Mine in Namibia had a strong second half in 2021 and finish to the year, resulting in new quarterly and annual gold production records. For 2021, the Otjikoto Mine produced an annual record of 197 573 ounces of gold, near the upper end of its guidance range (of between 190 000 and 200 000 ounces), and 18 percent (29 532 ounces) higher compared to 2020.

STRONGER IN 2021

In the fourth quarter of 2021, the Otjikoto Mine produced a quarterly record of 78 681 ounces of gold, in line with budget, and significantly higher by 96 percent (38 476 ounces) over the fourth quarter of 2020.

"As planned, with the completion of the pre-stripping campaigns at the Wolfshag and Otjikoto pits in the first half of 2021, Otjikoto's gold production increased significantly in the second half of 2021, as mining reached the higher-grade zone at the base of the Wolfshag Pit in the third quarter of 2021," Johnson said.

For full-year 2021, mill feed grade was 1.76 g/t compared to budget of 1.77 g/t and 1.52 g/t in 2020; mill throughput was 3.54 million tonnes compared to budget of 3.40 million tonnes and 3.51 million tonnes in 2020; and gold recovery averaged 98.6% compared to budget of 98.1 percent and 98.4 percent in 2020.

Capital expenditures totalled US$81 million in 2021, primarily consisting of US$41 million for pre-stripping for the Otjikoto Pit Phase 4 and Wolfshag Pit Phase 3, US$21 million for Wolfshag underground development, US$11 million in mobile equipment rebuilds and purchases and US$7 million for the national power grid connection line.

Capital expenditures for the fourth quarter of 2021 totalled US$22 million primarily consisting of US$8 million for pre-stripping for the Otjikoto Pit Phase 4, US$7 million for Wolfshag underground development, US$4 million for the national power grid connection line and US$3 million in mobile equipment rebuilds and purchases.

"Development of the Wolfshag underground mine continues to progress with ore production expected to begin in the first half of 2022. The initial underground mineral reserve estimate for the down-plunge extension of the Wolfshag deposit includes 210 000 ounces of gold in 1.2 million tonnes of ore at 5.57 g/t gold," Johnson concluded.

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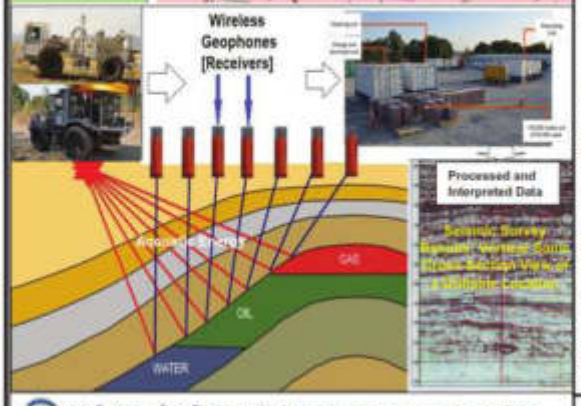

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Risk-Based Solutions (RBS) CC, URL: www.rbs.com.na

Technical Specialist Consultants, Permitting & De-Risking Advisors in Natural Resources covering Minerals Exploration & Mining / Petroleum Exploration & Production / Energy / Water / Environmental Assessments & Management (ESD, SEA, EIA, EMP, EMS)

REGISTER BY EMAIL: emerita.ashipala@gmail.com, Attention: Ms. Emerita Ashipala EAP/Independent Environmental Consultant / RBS Senior Consultant,
DEADLINE FOR WRITTEN SUBMISSIONS IS: FRIDAY 18th March 2022, date for the lodgement of the application for Environmental Clearance Certificate (ECC) is 30th March 2022

Figure 5.29: Copy of the half page public notice that was published in the Confidente newspaper dated 11th – 17th March 2022.

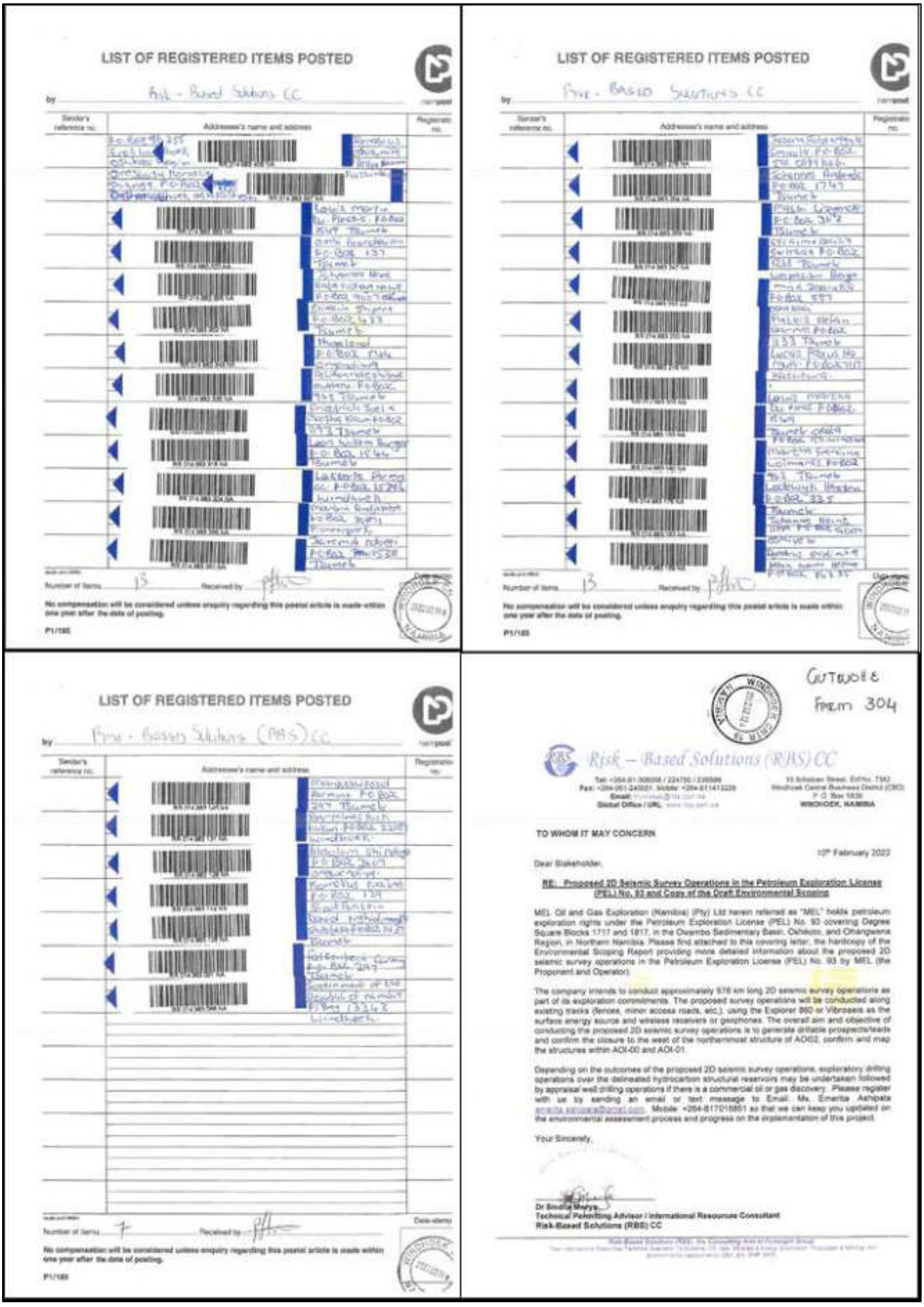

Figure 5.30: Copies of the written notifications / communications send to I&APs such as the Oshikoto Regional Council, Constituency Councillors, traditional authorities, and commercial and communal land owners with details provided in Annex 5.

5.7.4 Public, Stakeholder and Community Meetings Undertaken

The following is the summary of the public, stakeholder I&APs and community meetings undertaken with respect to the application for ECC for the proposed 2D seismic survey by MEL Oil and Gas Exploration (Plates 5.19-5.23 and Annex 5):

1. Institutional and Interested and I&APs meeting with the Oshikoto Regional Council including the Governor and his management team as well as the I&APs invited by the Council and the meeting took place on Tuesday, 22nd February 2022 and was held at Okashana Rural Development Centre, Omuthiya, Oshikoto Region (Plate 5.19).

2. Community Meeting on Farm Ondera, Government San Community Resettlement Farm falling in the AOI00, Guinas Constituency, Oshikoto Region and the meeting took place on Wednesday, 23rd February 2022. The meeting was also attended by the Communities from Ombili Farm, a San Community private Settlement Farm run under a Foundation and falling within the AOI00 in PEL 93 (Plate 5. 20).

3. Institutional and Interested and I&APs meeting with the Oshikoto Regional Council Hon. Councillors from the Constituencies covered by the AOI00 (Guinas Constituency), AOI01 (Nehale Lyampingana Constituency) and AOI02 (Eengodi Constituency) as well as the, traditional authority and I&APs invited by the Council and the meeting took place on Tuesday, 15th March 2022 and the meeting was held at Oshikoto Regional Council Offices in Omuthiya, Oshikoto Region (Plate 5.21).

4. Community Meeting, Omboto Village falling in the AOI01 in Nehale Lyampingana Constituency in Oshikoto Region and the meeting took place on Wednesday, 16th March 2022. The meeting was also attended by Communities from the surrounding areas falling within the AOI01 in PEL 93. The community meeting was organised through the Office of the Constituency Hon. Councillor and the Traditional Authority (Plate 5. 22)., and.

5. Community Meeting, Eengodi Regional Council Hall, Onamuishu, Settlement falling in the AOI02 in Eengodi Constituency in Oshikoto Region and the meeting took place on Thursday, 17th March 2022. The meeting was also attended by Communities from the surrounding areas falling within the AOI02 in PEL 93. The community meeting was organised through the Office of the Constituency Hon. Councillor and the Traditional Authority (Plate 5. 23).

Appropriate meeting delivery methods and materials were adapted for each of the institutional and community and stakeholder consultations and engagements processes undertaken.

5.7.5 Community Meetings Translations Undertaken

All the community meetings were translated or delivered in local languages as follow:

1. Community Meeting on Farm Ondera, Government San Community Resettlement Farm, Wednesday, 23rd February 2022: Translation provided by Mr. Erastus Naoxab.

2. Community Meeting held at Eengodi Regional Council Hall, Thursday, 17th March 2022: Ms Emerita Ashipala delivered all her presentations and answers in the local Oshiwabo language. The English presentations by Dr Sindila Mwiya (RBS) and Mr Robin Sutherland from (MEL), were translated by Mr Hosian Hitanwa supported by Ms Emerita Ashipala and the Hon. Councillor Procustius Neshuku of Eengodi Constituency, and.

3. Community Meeting held at Omboto Village Nehale Lyampingana Constituency, Wednesday, 16th March 2022: Ms Emerita Ashipala delivered all her presentations and answers in the local Oshiwabo language. The English presentations by Dr Sindila Mwiya (RBS) and Mr Robin Sutherland from (MEL), were translated by Mr. Jason Nghilalulwa supported by Ms Emerita Ashipala and the Hon. Councillor Johannes Shilongo of Nehale Lyampingana Constituency.

Plate 5.19: Overview of the Institutional and Interested and I&APs meeting with the Oshikoto Regional Council including the Governor and his management team as well as the I&APs invited by the Council and the meeting took place on Tuesday, 22nd February 2022 and was held at Okashana Rural Development Centre, Omuthiya, Oshikoto Region.

Plate 5.20: Community Meeting on Farm Ondera, Government San Community Resettlement Farm falling in the AOI00, Guinas Constituency, Oshikoto Region and the meeting took place on Wednesday, 23rd February 2022. The meeting was also attended by the Communities from Ombili Farm, a San Community private Settlement Farm run under a Foundation and falling within the AOI00 in PEL 93.

Plate 5.21: Institutional and Interested and I&APs meeting with the Oshikoto Regional Council Hon. Councillors from the Constituencies covered by the AOI00 (Guinas Constituency), AOI01 (Nehale Lyampingana Constituency) and AOI02 (Eengodi Constituency) as well as the, traditional authority and I&APs invited by the Council and the meeting took place on Tuesday, 15th March 2022 and the meeting was held at Oshikoto Regional Council Offices in Omuthiya, Oshikoto Region.

Plate 5.22: Community Meeting, Omboto Village falling in the AOI01 in Nehale Lyampingana Constituency in Oshikoto Region and the meeting took place on Wednesday, 16th March 2022. The meeting was also attended by Communities from the surrounding areas falling within the AOI01 in PEL 93. The community meeting was organised through the Office of the Constituency Hon. Councillor and the Traditional Authority.

Plate 5.23: Community Meeting, Eengodi Regional Council Hall, Onamuishu, Settlement falling in the AOI02 in Eengodi Constituency in Oshikoto Region and the meeting took place on Thursday, 17th March 2022. The meeting was also attended by Communities from the surrounding areas falling within the AOI02 in PEL 93. The community meeting was organised through the Office of the Constituency Hon. Councillor and the Traditional.

5.7.6 Summary of the Stakeholders Groups Consulted

Public notices were published in the local newspapers as shown in Figs. 5.22-5.29, registered letters were sent to the land owners as shown in Fig. 5.30, institutional stakeholders and traditional authorities, and meetings were organised with the Oshikoto Regional Council, Hon. Councillors, Traditional Authority, and the local communities with minutes of the meetings attached in Annex 5.

Based on all these consultation activities undertaken, the following is the summary of the key stakeholder groups that have been consulted during the months of February and March 2022 with respect to the proposed 2D seismic survey operations in PEL 93 with special focus on the areas covered by the AOI00 (Guinas Constituency), AOI01 (Nehale Lyampingana Constituency) and AOI02 (Eengodi Constituency):

(i) Central Government (Key line Ministries) and regulatory authorities.

(ii) Regional Councils in Oshikoto and Ohangwena Regions.

(iii) Constituencies covered by the AOI00 (Guinas Constituency), AOI01 (Nehale Lyampingana Constituency) and AOI02 (Eengodi Constituency).

(iv) Traditional / Tribal Authorities in Oshikoto Region.

(v) Distinguished registered and legally recognised local community organisations.

(vi) Communal and commercial farm owners.

(vii) Local communities.

(viii) Civil Society and conservation organisations.

(ix) General public, and.

(x) Other local, regional, and international interested parties.

5.7.7 Selection of the Appropriate Consultation Method and COVID-19 Protocols

Different types of engagement techniques have been used to share information, gather information, consult, and disseminate project information to the public, land owners, local communities, and stakeholders with respect to the proposed 2D seismic survey operations in PEL 93.

Culturally appropriate consultation methods and local languages translations were considered during all community consultations and engagements processes (Plates 5.24 – 5.26).

All the meetings took into consideration the national COVID-19 Protocols that were in place at the time of conducting the meetings. The following is the summary of the general community and stakeholder consultation and engagement approaches that were used (Plates 5.24 -5.26):

- Prepared formal project specific information and presentations when consulted government (Central, Regional or Local Authority) officials, and.

- When dealing with communities, targeted meetings with a mixture of the use of posters, handout leaflets, videos and formal interactive simple physical visual examples and translations into local languages.

The following is the summary examples of the specific delivery methods used at the various meetings:

1. Regulatory stakeholder consultation process combined PowerPoint presentations and posters sessions.

2. Community meetings were delivered using posters, printed handouts and simplified physical illustrations and local landscape examples to explain key aspects of the proposed project activities. The sediment infilling in the Etosha or local ephemeral rivers were 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 Etosha Pan and other local Pans and Ephemeral Rivers used to flow many years ago but now the channels have been filled-up by sediments, the channels are used for cultivation of crops and no longer flowing rivers.

3. The proposed 2D seismic survey operations were explained using detailed and enlarged images of the energy sources and receivers. Video of the vibrioses and Explorer 860 conducting seismic survey data acquisition in Brazil and Kavango East respectively were used to illustrate to the participants at meetings on how 2D seismic survey will be undertaken in their area (Plate 5.26).

4. Translations from English to local languages where required for all the community meetings were provided, and.

5. As part of the consultation and engagement activities, regulators, traditional authorities, local communities and interested key stakeholders were all given opportunities to ask questions and all the answers were translated accordingly.

Plate 5.24: Example of using formal power point presentation coupled with simplified physical illustrations and local landscapes such as the Etosha Pan and Omatako-Owambo Ephemeral River Channel to illustrate the various aspects of oil and gas formation in a Sedimentary Basin using a house kitchen and dining rooms areas to the oil and gas source and reservoir relationship as well as an option of renting out of Mahangu fields to another person for cultivation in return for a potential harvest sharing which is the same approach the State is taking in renting out oil and gas (petroleum) resources subsurface rights to international companies with funding and technical skills to developed the subsurface resources and hope share for the benefits of all Namibians in an event of a commercial discovery.

Plate 5.25: Example of using poster posters, and simplified physical illustrations and local landscapes such as the Etosha Pan and Omatako-Owambo Ephemeral River Channel to illustrate to the local communities the various aspects of oil and gas formation in a Sedimentary Basin using a house kitchen and dining rooms areas to the oil and gas source and reservoir relationship as well as an option of renting out of Mahangu fields to another person for cultivation in return for a potential harvest sharing which is the same approach the State is taking in renting out oil and gas (petroleum) resources subsurface rights to international companies with funding and technical skills to developed the subsurface resources and hope share for the benefits of all Namibians in an event of a commercial discovery.

Plate 5.26: The proposed 2D seismic survey operations were explained using detailed and enlarged images of the energy sources and receivers. Video of the vibrioses and Explorer 860 conducting seismic survey data acquisition in Brazil and Kavango East respectively were used to illustrate to the participants at meetings on how 2D seismic survey will be undertaken in their area.

5.7.8 Discussion of Stakeholder Submissions and Issues Raised Meetings

Submissions by stakeholders and issues raised at all the meetings have all been reviewed, evaluated and incorporated in the preparation of this EIA Report and a separate EMP Report. Minutes of the key stakeholders, public and community consultation and engagement activities conducted between February and March 2022 are attached to this EIA report in Annex 5 together with one (1) written submission that was made by Mr. Jan Arkert, a South African resident representing Frack Free Namibia in Namibia.

The following is the summary of the review and incorporation of the written submission made by Mr. Jan Arkert as attached in Annex 5:

(i) **Introduction 1**: Submission is hereby acknowledged as addressed in this section of this EIA Report.

(ii) **Environmental Assessment Practitioner 2:** The submissions made by Mr. Jan Arkert, a South African resident representing Frack Free in Namibia focused on Dr Sindila Mwiya and website marketing materials about Risk-Based Solutions are irrelevant to the subject matter with respect to the application for ECC for the proposed 2D seismic survey operations in PEL 93. According to Dr S. Mwiya, the unfounded and frustrated personal attacks on him by Mr. Jan Arkert are unfortunate personal acrimony emanating from previous failed initiatives of Mr. Jan Arkert linked to other developmental activities that are ran by Dr Mwiya and taking place in Namibia and unrelated to South Africa.

With more than 200 EIA Projects undertaken, twenty (20) years of appropriate and relevant permitting experience in onshore and offshore oil and gas exploration and production, coupled with great and highly technical academic excellence to a level of a PhD held by Dr Sindila Mwiya, this is not and cannot in any way be a basis for a conflict of interest for any judicious person.

The EAP for this project is Ms. Emerita Ashipala, a qualified and experienced consultant, proficient in the local Oshiwambo language used most of the residents in the license area PEL 93 and AOI. Ms Ashipala was designated EAP during the public consultation process stage of the project.

A single-handed EAP does not conduct Environmental assessments. Several specialists with different expertise are involved in this environmental assessment process. The CVs of the specialist consultants and other team members that have been involved in this EIA process are provided in Annex 6 of this Report.

(iii) **To Frack or Not to Frack 3:** This is public fear mongering assertion and irrelevant to the subject matter of conducting the proposed 2D seismic survey.

(iv) **Community Consultations 4:** Community consultations were successfully conducted in Oshikoto Region with full support for the proposed project by the regional leadership, traditional authority, and local communities consulted (Annex 5). Supported by the whole team, meetings were led by Ms. Emerita Ashipala who is a qualified and experienced consultant and speaks the local language used by most of the residents in the license area and AOI (PEL 93).

(v) **To Cut or Not to Cut 5**: Likely negative impacts of new survey cutlines have been addressed in this EIA under Chapter 6 with mitigation measures provided in the EMP.

(vi) **Unrealistic Time Lines 6:** Appropriate times lines in conducting the EIA Process have been addressed under Chapter 2 and provided for in this EIA in line with the provisions of the EIA Regulations, 2012.

(vii) **Waves or Lines 7:** Wave lines referring to the impacts of seismic survey operations on elephants are fully and mathematically addressed in this EIA under Sections 3.5.1, 6.4.3.2,

6.4.3.5 and 6.4.3.16 and Figs. 6.1 and 6.2 and with mitigation measures provided in the EMP.

(viii) **3 x 4 +C = Low Impact 8:** The impact assessment process and methodology are fully explained in Chapters 2 and 6 of this EIA Report. The proposed 2D seismic survey operations represent a localised operation with local implications and is not a complex project and will have no international ramifications whatsoever as amplified in the submission of Mr. Jan Arkert.

(ix) **Conclusion 9:** In terms of the Strategic Environmental Assessments (SEA) recommendations are irrelevant to the proposed project activities because the Proponent is undertaking project level activities requiring an EIA to support the application for an ECC. A SEA can only be undertaken by an Organ of State linked to a Policy, Plan and Programme (PPP) and such PPP strategies have been undertaken by various line ministries and regional governments in Namibia and future PPP will be undertaken based on developmental direction and needs of the State and Namibian citizens. Section 1.3.4 of this EIA address issues related to SEA and EIA requirements. Environmental Assessment Professionals Association of Namibia (EAPAN) is a voluntary organisation with no statutory provisions whatsoever. This voluntary organisation is called EAPAN not EPAN as contained in the conclusion submission of Mr. Jan Arkert (Annex 5) which is also referring to the nonexistence of not only EPAN but also Dr Siyanda Mwiya.

Overall, however, relevant general subject matters related to the application for the ECC for the proposed 2D seismic survey in PEL 93 as contained in the submission of Mr. Jan Arkert have been addressed in this EIA Report and the separate EMP Report.

The following is the general summary of the key issues that were raised at the various meetings conducted in Oshikoto Region with detailed answers provided in the Annex 5 to this EIA Report for the proposed 2D seismic survey operations:

1. Petroleum exploration (2D seismic) and the associated environmental, social impacts and permitting standings.

2. Need for continuous consultation and engagements of the regional councils, traditional authorities, and local community.

3. Continuous updates of the regional and traditional authorities' leadership on project progress and outcomes.

4. Social aspects (socioeconomic benefits from 2D seismic).

5. Social aspects (employment and recruitment processes).

6. Local community expectations and realities on the ground especially because the proposed activities are part of an ongoing exploration programme with limited Corporate Social Responsibility or Environmental, Social and Governance (ESG) commitments.

7. 2D seismic survey activities' potential impacts associated with community crop fields, villages, water wells / boreholes and clearing of vegetation.

8. Climate Change and Climate Change global, regional and local movements, moving away from fossil fuels, environmental activism and extremism, radical environmentalism, global, regional (SADC), and national security, and some media houses, civil societies and foreign individuals deliberate Social Media misinformation campaigns and local fearmongering centred on financial gains and attraction of international donations at the expense of the poor rural communities from Oshikoto and Ohangwena Regions overwhelmed by inherited generational poverty.

9. Petroleum agreement and the small 10% local participation interests of Namibia through Namcor, and.

10. Need for a Strategic Environmental Assessment (SEA) instead of an EIA.

Overall, key concerns from the stakeholders and community consultations and engagement 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, MEL has committed to employing local people, work with local communities and uplift the lives of the local community through Environmental, Social, Governance (ESG) projects with special focus on procuring local goods and services to support the proposed 2D seismic survey operations.

Most of the questions and comments raised were focused on local community benefits within the framework of any future discovery of economic oil and/ or gas resources in region. It is important to note that MEL currently holding a Petroleum Exploration License (PEL) No. 93 and this license is for exploration not for producing oil or gas.

The reason for conducting the seismic survey is to search for a suitable location that could hold potential economic oil or gas reserves within the license area. If the seismic survey finds a potential suitable location, a separate ECC will be required before the company can conduct exploration well drilling operations.

If the exploration well drilling discovers oil or gas or both, a separate ECC for appraisal testing / evaluation wells drilling operations will be required. 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 search for oil and gas takes many years and even if oil or gas is discovered in the license area it will take 2-5 years to develop the resources and start to generate income.

The proposed 2D seismic survey has been undertaken in Namibia and other parts of the World and has proven not to affect the receiving environment or local infrastructures. 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.

6. IMPACT ASSESSMENT

6.1 Assessment Procedure

The environmental assessment process adopted for this project took into consideration the provisions of the Petroleum Agreement signed between MEL 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. The overall impact assessment adopted the Leopold matrix framework which is one of the internationally best-known matrix assessment methodology available for predicting the impacts of a project on the receiving environment. The assessment process took into consideration the proposed activities, trade-offs, and alternatives. Key mitigation measures for identified significant impacts are provided in the EMP Report.

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 are site-specific and related to the regional and local geology and petroleum system of a specific area to which there are no alternative 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 with key sensitive areas such as proclaimed national parks excluded from license area.

(ii) **Profiles / survey lines km length, roads, farm fences boundary lines, tracks, and possible new cutlines created:** The proposed 2D seismic survey operations will be undertaken along north-south and east west oriented existing roads, farm fence boundaries and tracks as well as the proposed new possible cutlines. New cutlines will only be created if the landowners approve to the creation of such a new cutline. Several alternative roads, farm fence boundaries and tracks have been identified and exist within the survey area of interest. Such alternative routes for survey lines have been identified and includes: Other existing roads, farm fence boundaries, community tracks, trails, unused cleared, and already disturbed / cleared areas.

(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 93 has been undertaken. The proposed survey will either use the vibroseis or Explorer 860 subject to availability, cost, and environmental considerations. The Proponent has not yet issued a contract for the third-party services provider who will be undertaking the proposed 2D seismic survey. Both the vibroseis and Explorer 860 have been previously used for 2D seismic survey operations in Namibia.

(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 wireless receivers with the latest, smallest, and most easily deployable system on the market. The wireless receivers will provide wider lines offset 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 no negative environmental impacts due to proposed activities will occur 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 localised, the current and other future land uses will still have some negative impacts on the local 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 include: 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 to 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 in PEL No. 93 using the proposed 2D seismic survey data sets 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 Oshikoto Region. Land use is dominated by communal subsistence agricultural comprising livestock and seasonal crop farming practices. No conservancies and or community forest exist in the AOI. Due to the limited scope of the proposed 2D seismic survey operations centred around the existing roads, farm fences boundary lines, tracks, and possible new cutlines created, it is likely that the proposed activities will coexist with the current and future land 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, farm fence boundaries and track as well as along the proposed new cutlines subject to the approval of the land owner.

(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, farm fence boundaries and track as well as along the proposed new cutlines subject to the approval of the land owner.

(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 along existing roads, farm fence boundaries and track as well as along the proposed new cutlines subject to the approval of the land owner, 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. 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 along the existing roads, farm fence boundaries and track as well as along the proposed new cutlines subject to the approval of the land owner targeting potential deep-seated subsurface potential geological resources.

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 all had to be evaluated as part of the impact assessment process for the proposed 2D seismic survey operations. Mitigation objectives are set (i.e. ways of reducing negative impacts), and attainable management actions are subsequently addressed in the EMP for all the negative impacts with high or medium significance rating. 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 of 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.

Rating	Definition of Rating
Status of the Impact – in terms of meeting the objective of maintaining a healthy environment.	
Positive	The impact benefits the environment
Negative	The impact results in a cost to the environment
Neutral	The impact has no effect
Probability – the likelihood of the impact occurring	
Negligible	Possibility negligible
Improbable	Possibility very low
Probable	Distinct possibility
Highly Probable	Most likely
Definite	Impact will occur regardless of preventive measures
Degree of confidence in predictions – in terms of basing the assessment on available information	
Low	Assessment based on extrapolated data
Medium	Information base available but lacking
High	Information base comparatively reliable
Extent – the area over which the impact will be experienced	
Site specific	Confined to within < 1 km of the project
Local	Confined to the study area or within 5 km of the project
Regional	Confined to the region, i.e. > 5 km but < National
National	Nationally
International	Beyond the borders of Namibia
Duration – the time frame for which the impact will be experienced	
Very short	Less than 2 years
Short-term	2 to 5 years
Medium-term	6 to 15 years
Long-term	More than 15 years
Permanent	Generations
Intensity – the magnitude of the impact in relation to the sensitivity of the receiving environment	
Negligible	Natural functions and processes are negligibly altered due to adaptation by the receptor(s) to high natural environmental variability
Mild	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)
Moderate	Natural functions and processes continue albeit in a modified way that **does** appear to have a noticeable disruptive effect (i.e. changes are permanent)
Severe	Natural functions or processes are altered to the extent that they temporarily cease resulting in severe deterioration of the impacted environment
Very Severe	Natural functions or processes permanently cease or are completely disrupted

Table 6.2: The criteria used to determine the significance rating of the impact(s).

Low	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.
Medium	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.
High	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.

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:

- Planning and mobilisation (Pre-survey preparation, field scouting and mapping of buffers and offsets along proposed survey lines).
- Base camp and fly-camps site setups and operations.
- Widening of existing tracks and farm fences access by pruning vegetation overgrowth and tracks levelling as may be applicable.
- Creating access across various farm fences and fixing of affected fences immediately after the survey / data acquisition drive through.
- Creation of new access for current and possible future infill survey.
- Actual survey operation (data acquisition).
- Demobilisation and closure (Survey Completion), and.
- Any accidental event that may be associated with the routine and physical presence operational activities.

6.4.2 Likely Positive Impacts

6.4.2.1 Summary of Likely Positive Impacts

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

1. Payment of the annual license rental fees to the Central Government averaging N$ 1.2 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.
2. USD 50, 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.

3. 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.

4. The need for pruning and opening-up of some of the inaccessible sections of the tracks and roads to be used for the proposed 2D seismic survey operations will provide temporary employment opportunities for the local people for periods of between 3-4 months.

5. The pruning and opening-up of some of the inaccessible sections of the tracks and roads to be used for the proposed 2D seismic survey operations will improve access and connect local communities.

6. The pruning and levelling of the tracks and roads for the survey lines running along existing tracks oriented in the north-south and east-west directions along the boundaries of the large-scale agricultural commercial farming units on communal land and along commercial farms will improve access to the farming units and greatly benefit the local farmers in their quest to reach markets for their livestock and produce, and.

7. Although forest fire kills diseases and insects that prey on trees and keeps the forest healthy and provides valuable nutrients that enrich the soils, uncontrolled wildfires are enormously destructive to the rural livelihoods, the creation of new cutting lines with the approval of the local farmers / land owners may positively contribute to forest and local farm management strategies that will prevent uncontrolled wildfires and will protect the natural resources base of the local people. Such rural resources base include: Wild fruits, timber, firewood, building logs, thatch grass, crop fields and crop production as well as pasture and livestock production areas. However, the creation of the new cutlines along the large-scale agricultural commercial farming units on communal land and commercial farms shall take into consideration the concerns, priorities and existing knowledge and practices of the local people / land owners.

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.

Continued contribution to local, regional, and national economy through payment of the annual license rental fees to the Central Government averaging N$1.2 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	*Status*	Positive
	Probability	Definite
	Confidence	High
	Extent	National
	Duration	Short-term
	Intensity	Moderate
	Significance	High

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

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	*Status*	Positive
	Probability	Definite
	Confidence	High
	Extent	National
	Duration	Medium-Term
	Intensity	High
	Significance	Medium

Table 6.5: Expansion of the subsurface national 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	*Status*	Positive
	Probability	Definite
	Confidence	High
	Extent	National
	Duration	Long-term
	Intensity	High
	Significance	High

Table 6.6: Support rural communities through Environment, Social Governance (ESG) and Corporate Social Responsibility (CSR) initiatives.

Contribution to the development and upliftment of local rural communities through Environment, Social Governance (ESG) and Corporate Social Responsibility (CSR) initiatives	*Status*	Positive
	Probability	Definite
	Confidence	High
	Extent	Local
	Duration	Permanent
	Intensity	High
	Significance	High

Table 6.7: Provisions of short-term contractual employment opportunities.

Short-term contractual employment opportunities (3-4 months) for the local communities during the proposed 2D seismic survey operations	*Status*	Positive
	Probability	Definite
	Confidence	High
	Extent	National; Employees are mostly from Namibia, with fewer from other countries such as Canada.
	Duration	Short-term
	Intensity	High
	Significance	High; a significant number of especially rural families in the project area will benefit in terms of short-term employment and wages.

Table 6.8: Improve access for the local communities.

The pruning and opening-up of some of the inaccessible sections of the tracks and roads to be used for the proposed 2D seismic survey operations will improve access for the local communities	*Status*	Positive
	Probability	Definite
	Confidence	High
	Extent	Local
	Duration	Permanent
	Intensity	High
	Significance	High

Table 6.9: The pruning and levelling of the tracks and roads for the survey lines running along existing access.

The pruning and levelling of the tracks and roads for the survey lines running along existing tracks and farm boundaries will improve access and greatly benefit the local farmers in their quest to reach markets for their livestock and produce	*Status*	Positive
	Probability	Definite
	Confidence	High
	Extent	Local, Regional and National
	Duration	Permanent
	Intensity	High
	Significance	High

Table 6.10: The cutting of possible new cutlines with the approval of the land owners is a vital part of the local community forest and commercial farm land management strategies that will prevent uncontrolled wildfires and thus protects the natural resource base and livelihood of the local people and land owners.

The cutting of possible new cutlines with the approval of the land owners is a vital part of the local State and private farms forest and land management strategies that will prevent uncontrolled wildfires and thus protects the natural resource base and livelihood of the local people and land owners	*Status*	Positive
	Probability	Definite
	Confidence	High
	Extent	Local and Regional
	Duration	Permanent
	Intensity	High
	Significance	High

6.4.2.2 Summary of Likely Positive Cumulative Impacts

Positive cumulative benefits for the country and local communities 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 communities 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 additional positive impacts through continued contributions by MEL to the national Petroleum Training and Education Fund (PETROFUND) and payment of license rental fees in addition to the contributions by other oil and gas exploration companies operating in Namibia. Other additional benefits in addition to all other opportunities and contributions being offered by Government and other companies in Namibia and in Oshikoto and Ohangwena Regions include the following:

(i) Temporary contracts and employment opportunities.

(ii) Contribution to the development and upliftment of local rural communities through Environment, Social Governance (ESG) and Corporate Social Responsibility (CSR) initiatives.

(iii) Improve access to the large-scale agricultural commercial farming units on communal land and private commercial farmland and greatly benefit the local farmers in their quest to reach markets for their livestock and produce, and.

(iv) The cutting of the proposed new cutlines with the approval of the land owners will contribute to the local community State and private land and forest management strategies and prevent uncontrolled wildfires and thus protects the natural resource base and livelihood of the local people and land owners within the proposed project area in PEL 93.

Table 6.11 summarises the results of the positive cumulative impact assessment with respect to the proposed 2D seismic survey operations.

Table 6.11: Likely positive cumulative impacts.

Likely Positive Cumulative Impacts	*Status*	Positive
	Probability	Definite
	Confidence	High
	Extent	Local
	Duration	Permanent
	Intensity	High
	Significance	High

6.4.3 Likely Negative Impacts of the Proposed 2D seismic survey

6.4.3.1 Summary of Likely Negative Impacts

Based on the findings of this EIA Process, the following is the summary of the key likely negative environmental impacts that the proposed 2D seismic survey activities may have on the receiving environment:

1. Disruption / disturbance of the habitats.
2. Reptiles.
3. Amphibian.
4. Mammals especially elephants.
5. Avian.
6. Tree and shrub species.
7. Grass.
8. Socioeconomic environment.
9. Existing infrastructure, current and future land uses.
10. Ecosystem functions, services, use values and non-use or passive use.
11. Physiography and geology.
12. Visual and land degradation.
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).
16. Community and workers security, public safety, Occupational Health, and Safety.
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 list of receptors of the receiving environment likely to be negatively impacted by the activities of the proposed 2D seismic survey operations in PEL 93 have been revaluated during the EIA process of preparing this EIA Report with mitigation measures for significant negative impacts provided in a separate EMP Report.

6.4.3.2 Likely Negative Impacts on the Disruption / Disturbance of the Habitats

Important habitats in the general area are: Omuramba Owambo, Omuramba Omuthiya, Etosha National Park and the Mangetti Block which is an important elephant movement between the Etosha National Park and the Mangetti farms (Fig. 6.1 and Annex 2). The most important habitat areas in the general PEL and surrounding areas are (Fig. 6.1 and Annex 2):

(i) Ephemeral Omuramba Owambo and Omuthiya

(ii) Ephemeral Pans.

(iii) Etosha National Park.

(iv) Mangetti Block, and.

(v) Undisturbed areas.

Overall, however, the general area has been heavily impacted in places, especially close to towns, villages, and settlements such as Oshivelo, etc.; crop production and land clearing on freehold farms; subsistence farming activities in communal areas, etc. and none of the unique trees and shrubs are expected to be exclusively associated with the seismic survey routes in AOI00, AOI01 and AOI02 (Plates 5.17 and 5.18, Fig. 6.1 and Annex 2).

Habitat destruction, due to the creation of new tracks and widening of existing access, is more important although the actual footprint is likely to affect local cleared areas. 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 6.12).

Table 6.12: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities with respect to the disruption / disturbance of the habitats along existing access and new firebreak cutlines and any associated extensions.

Disturbance of the disruption / disturbance of the habitats within PEL 93, survey area and key areas of interests and the surrounding areas along the existing access and new cutlines	*Status*	Negative
	Probability	Probable; the proposed survey will use existing infrastructure areas / focus on already disturbed areas. The creation of new cut lines for the proposed lines 5, 8, 12 and 15 shall only be undertaken if such a proposal has been approved by the affected land owner/s. The total length of the lines that may be created is 105 km. The creation of the cutlines shall be undertaken selectively and all mature and protected trees shall not be cut.
	Confidence	High
	Extent	• Overall impact will be site-specific. Access routes - Localised disruption/destruction of the habitat and thus consequently fauna associated directly with the actual routes. This however, would be a relatively limited area with localised implications along the cleared new cutlines.
	Duration	Short for existing access and permanent for the new cutlines and any associated new extensions
	Intensity	• Medium to High. Access routes (existing) and new cutlines- The actual sites where expansion of the existing route(s) and new cutlines would be permanently altered. This however, would be relatively localised area(s) with localised implications along the cleared areas. • 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 pruning for existing access and clearing for new cutlines, but should be limited to localised implications. • Areas not directly affected by the routes (existing) and new firebreak cutlines although within the immediate area would be affected minimally. This would include dust, noise, light & other associated disturbances in the area, but be limited to the cutlines clearing and seismic activity.
	Significance	Medium to High Localised Impacts

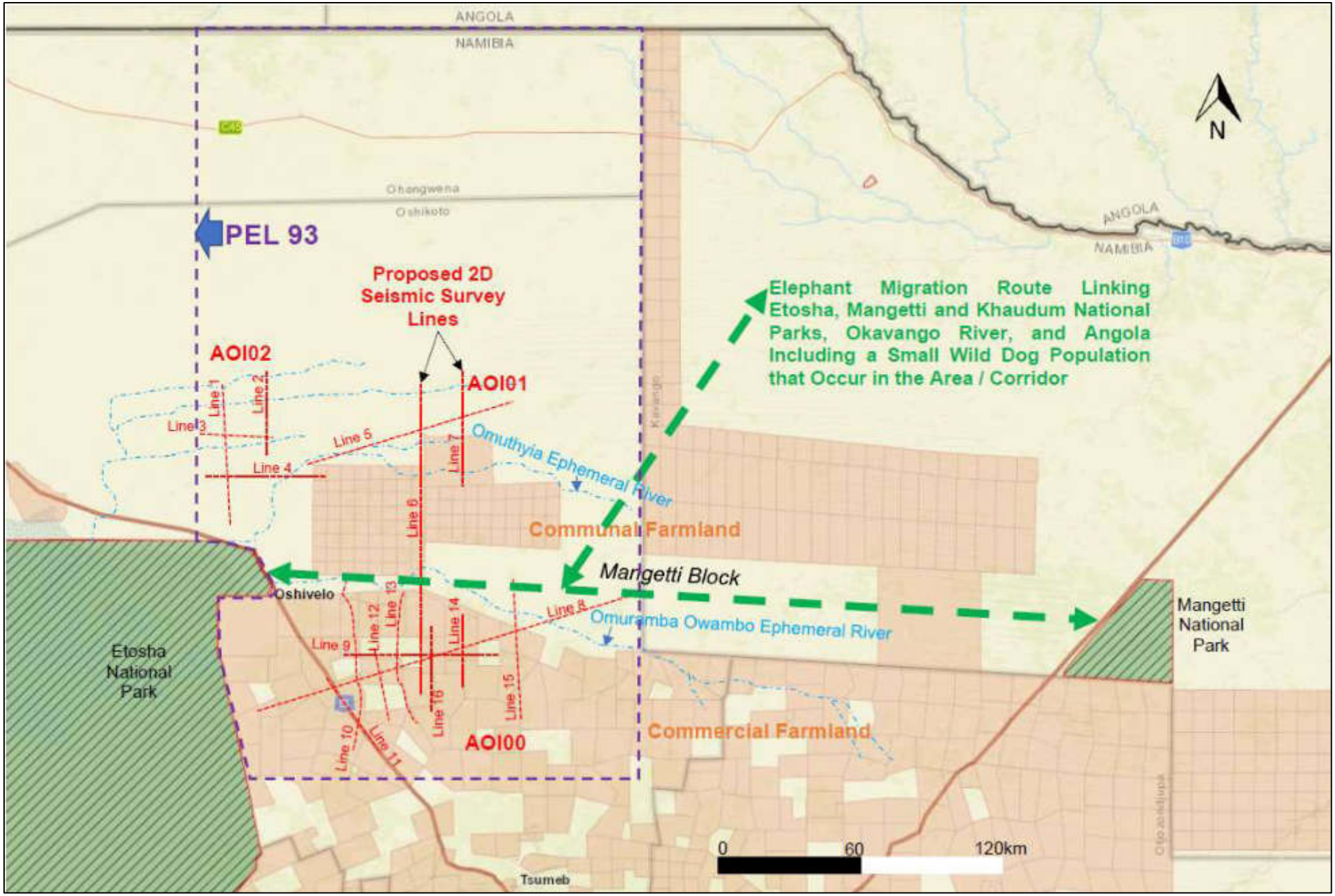

Figure 6.1: Important habitats in the general area are: Omuramba Owambo; Omuramba Omuthiya, Etosha National Park, and the Mangetti Block. Elephant movement between the Etosha National Park and the Mangetti farms are indicated (broken green arrows). The red dotted lines are the seismic lines over AOI00, AOI01 and AOI02 (Base map Source: https://maps.landfolio.com/Namibia/).

6.4.3.3 Likely Negative Impacts on Reptiles

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 6.13).

The results of the likely negative impacts of the proposed 2D seismic survey on reptiles 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 reptiles.

Likely negative impacts of the proposed 2D seismic survey on reptiles and their associated habitats	*Status*	Negative
	Probability	Probable
	Confidence	High
	Extent	Site-specific along new cutlines
	Duration	Existing access, short for duration of the survey and permanent for the new cutlines
	Intensity	Mild
	Significance	Medium to Low

6.4.3.4 Likely Negative Impacts on Amphibian

Survey lines will merely cut across such Ephemeral Rivers in certain areas. The results of the likely negative impacts of the proposed 2D seismic survey on amphibians and their associated habitats are summarised in Table 6.14.

Table 6.14: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on amphibians.

Likely negative impacts of the proposed 2D seismic survey on amphibians and associated habitats	*Status*	Negative
	Probability	Improbable survey lines will not run along an Ephemeral River
	Confidence	High
	Extent	Site-specific
	Duration	Very Short; for duration of the survey
	Intensity	Mild
	Significance	Medium to Low

6.4.3.5 Likely Impacts on Mammals Including Elephants

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). A vibroseis truck such as a Nomad will have a wide range of frequency bands ranging from 0-250 Hz. 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 mammals 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 15-35 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).

Intuitively, loud noise is more disruptive than quiet noise (Weisenberger et al., 1996) and noise with frequencies like animal vocalisations is more likely to interfere with (i.e., mask) communication than noise with different frequencies (Bernard Lohr et al., 2003). Most anthropogenic noise sources have energy concentrated in low frequencies (<250 Hz), which can travel long distances with relatively little energy loss. Such noise is also more difficult to control using traditional noise-abatement structures. Spatial patterning of noise may also affect the level of disturbance or interference. Interference is defined as the effect produced when two waves of the same frequency, amplitude and wavelength travelling in the same direction in a medium are superposed (i.e. as they simultaneously pass-through a given point). When the crest of two waves of equal wavelength is together, the waves are said to be in phase, that is, they have a phase difference of zero. In this case, according to the principle of linear superposition, the waves will reinforce each other, or add up and will undergo **constructive interference** and thus affect elephant vocalisation (Fig. 6.2). According to Fig. 6.2, if two waves superimpose with each other in opposite phase, the amplitude of the resultant is equal to the difference in amplitude of individual waves, resulting in the minimum intensity of the wave. This is known as **destructive interference** and thus will produce a negligible effect on elephant vocalizations (Fig. 6.2).

One of the most recent studies on noise and vibration matters looked at how elephants show risk-avoidance behaviour in response to human-generated seismic cues (Mortimer et al., 2021). African elephants use a variety of sensory modes, whether for communication through signals (Soltis, 2010; Hollister-Smith et al., 2008) or for information gathering by detecting cues generated by other animals (e.g., predator odour (Valenta et al., 2021)), humans (e.g., voices (McComb et al., 2014), roads/ railways (Okita-Ouma et al., 2021) or natural earth processes (e.g., rainfall (Garstang et al., 2014). Information transfer through ground-based, or seismic, vibrations is the least well-understood (O'Connell-Rodwell, 2007). Elephants likely detect seismic information using the Pacinian corpuscles on the feet and/or the inner ear, picking up ground vibrations via bone conduction (Bouley et al., 2007). Elephants are thought to use seismic signals to communicate with each other, as seismic vibrations are generated by elephants during certain infrasonic vocalizations, known as rumbles (Poole et. al., 1988; Sharma et al., 2020; Soltis et al., 2014).

The rumbles contain both acoustic and seismic components in the frequency range 20–40 Hz and under (Langbauer et al., 1991; O'Connell-Rodwell et al., 2000; O'Connell-Rodwell et al., 2001), which are modelled to propagate to a maximum of 6 km under differing favourable conditions (Mortimer et al., 2018; Larom et al., 1997a; Larom et al., 1997b). This study explained that the African elephants (*Loxodonta africana*) use many sensory modes to gather information about their environment, and even in the detection of seismic, or ground-based, vibrations. This Seismic information is known to include elephant-generated signals, but also potentially encompasses biotic cues that are commonly referred to as 'noise'. It was shown that after the generation of noise/vibration, this African elephants were able to detect and discriminate between seismic vibrations that differ in their noise types, whether elephant- or human-generated.

A good evidence of retreat behaviour, where seismic tracks with human-generated noise caused elephants to move further away from the trial location (Mortimer et al., 2021). This study has shown that elephants can avoid human generated frequencies and distinguish it from their own because there is no constructive interference as illustrated in Fig. 6.2.

Additionally, 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 in 2007 and south of Nkurenkuru in Kavango West Region in 2017 as well as the completed 2D seismic survey wildlife monitoring in PEL 93, no significant negative environmental impacts have been observed and reported on all components of the receiving environment. 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 and especially the old and poorly engineered infrastructure.

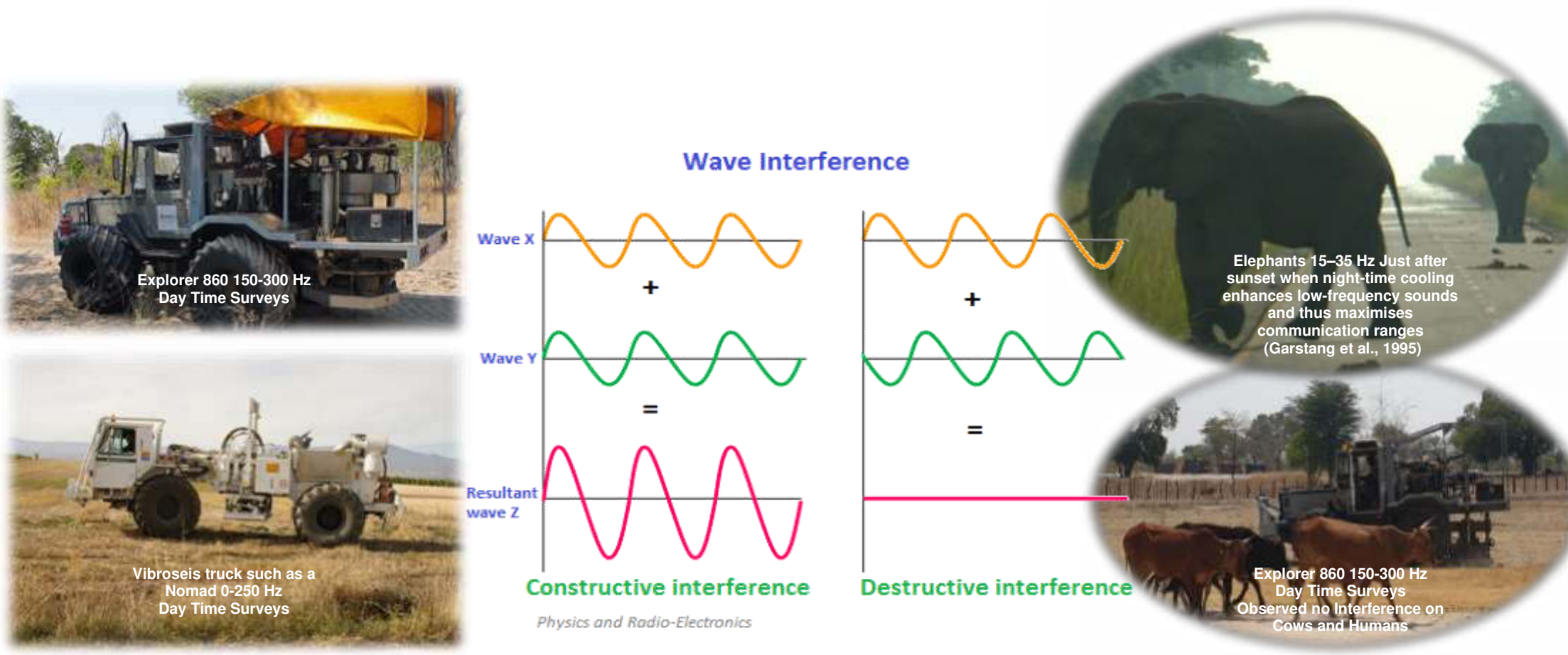

Figure 6.2: Illustration of the principle of linear superposition, the waves will reinforce each other, or add up and will undergo constructive interference and thus affect elephant vocalisation. On the other hand, if two waves superimpose with each other in opposite phase, the amplitude of the resultant is equal to the difference in amplitude of individual waves, resulting in the minimum intensity of the wave. This is known as destructive interference and thus will produce a negligible effect on elephant vocalisations. It is very important to note that the waves generated by a 2D seismic survey are different from the earthquake created seismic waves. Earthquake generated seismic waves have periods, and wavelength that are in minutes and kilometres, respectively, while the 2D seismic survey operations produces waves with periods, and wavelength of tenths of a second and tens of a meter respectively.

Overall, it is very important to note that the waves generated by a 2D seismic survey are different from earthquake created seismic waves. Earthquake generated seismic waves have periods, and wavelength that are in minutes and kilometres, respectively, while the 2D seismic survey operations produces waves with periods, and wavelength of tenths of a second and tens of meters respectively. Therefore, the level of ground displacement associated with the type of waves generated by an onshore seismic survey operation compared to an earthquake event, differs considerably. Earthquake ground displacement are in meters and can result in weak buildings collapsing while the millimetre / few centimetres onshore seismic survey operations ground displacement will generally have negligible effect on the buildings.

Studies have shown that noise and vibration may interfere with elephant's vocalisation only when the noise and vibration have the same frequencies as that of the elephant (Jessica *et. al*., 2010). Elephants operate at the frequency of between 15– 35 Hz. The Explorer 860 or vibroseis both have frequencies that differ with that of Elephant. Hence, an insignificant interference (Fig. 6.2). 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.

Only one (1) seismic survey line cut across the occasional elephant activities / migration corridor (Fig. 6.1). The survey will be conducted only during the day times using impulse frequency of 150-300Hz for the Explorer 860 and of more than 35Hz and up to 250Hz for a vibroseis truck such as a Nomad and both energy sources have far above the narrow frequency range of between 15-35 Hz used by elephants for communication (Fig. 6.2).

MEL shall appoint wildlife expert and together with the team of Community Liaison Officers (CLOs) will monitor wildlife activities including elephant activities when operating in the affected sections of the survey lines. Authorities and stakeholders will be notified on the start of the seismic survey to monitor animals as may be applicable and especially geotagged elephant by MEFT.

The results of the likely negative impacts of the proposed 2D seismic survey on mammals and their associated habitats are summarised in Table 6.15.

Table 6.15: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on mammals.

Likely negative impacts of the proposed 2D seismic survey on mammals and associated habitats	*Status*	Negative
	Probability	Improbable
	Confidence	High
	Extent	Site-specific
	Duration	Very Short; for duration of the survey
	Intensity	Mild
	Significance	Medium to Low

6.4.3.6 Likely Impacts on Avian

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) while a vibroseis truck such as a Nomad has a wider frequency choice ranging from 0-250 Hz. 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.

Any 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 6.16). The results of the likely negative impacts of the proposed 2D seismic survey on avian and their associated habitats are summarised in Table 6.16.

Table 6.16: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on avian.

Likely negative impacts of the proposed 2D seismic survey on avian and associated habitats	*Status*	Negative
	Probability	Improbable
	Confidence	High
	Extent	Site-specific
	Duration	Very Short; for duration of the survey
	Intensity	Low
	Significance	Low

6.4.3.7 Likely Impacts on Trees and Shrubs

The creation and widening of new tracks and creation of new cutlines will affect local trees and shrubs especially along the actual 105km long new cutlines to be created subject to the approval or request by the land owners if such a new cutline/s will provide additional positive land management benefits such as control of wildfires or improve access for the farmers / local community within the general area. The creation of new access in consultation with the land owners would however not lead to additional habitat disturbances and increased access into areas currently not as easily accessible which could lead to the disruption / disturbance of the habitats within survey lines and surrounding areas.

It is hereby highly recommended that the creation of new cutlines with respect to lines 5, 8, 12 and 15 shall be subject to the approval or request by the land owner/s and shall be supervised by MEL and the land owners. The pruning of vegetation and levelling along existing tracks and roads will not affect tree and shrub and no big and protected flora species shall be cut down unnecessarily. Big and protected flora shall be incorporated in the cutline profile.

The fly-camp sites will be situated on areas which are already cleared / disturbed. No vegetation will be removed for the temporary fly-camp sites. The results of the likely negative impacts of the proposed 2D seismic survey on tree and shrub as key habitats are summarised in Table 6.17.

Table 6.17: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on tree and shrub species.

Likely negative impacts of the proposed 2D seismic survey on tree and shrub species as key habitats and resources	*Status*	Negative
	Probability	Probable
	Confidence	High
	Extent	Site-specific
	Duration	Medium-term
	Intensity	Low
	Significance	Medium to high for new firebreak cutlines

6.4.3.8 Likely Impacts on Grass

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**.**

The creation of new cutlines may 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 6.18.

Table 6.18: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on grass.

Likely negative impacts of the proposed 2D seismic survey on the grass as key habitats and resources	*Status*	Negative
	Probability	Probable
	Confidence	High
	Extent	Site-specific
	Duration	Medium-term
	Intensity	Low
	Significance	Medium to high for new firebreak cutlines

6.4.3.9 Likely Socioeconomic Impacts

One of the major possible negative impacts may be unrealistic job expectations about the proposed project. It is important for local communities to bear in mind that the proposed 2D seismic survey activities will be for a short period of time (3-4 months). 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 to employ local people 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 in local 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 from 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, and.

(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 6.19.

Table 6.19: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on the socioeconomic environment.

Likely negative impacts of the proposed 2D seismic survey on the socioeconomic environment	*Status*	Negative
	Probability	Probable
	Confidence	High
	Extent	Local
	Duration	Very short
	Intensity	Low
	Significance	Low

6.4.3.10 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 6.1).

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 not that heavy duty (Plate 6.1).

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 do not cut across a proclaimed protected area (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.).

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 expanded over these areas.

The creation of new 105 km long cutlines (Lines 5, 8, 12 and 15) in pristine areas if not managed well, could result in the destruction of numerous protected tree species. The cutlines may also open new accesses to these areas leading to potential illegal harvesting of forest resources, poaching and overall environmental destruction and new settlements / villages. However, these new cutlines are equally important for land and forest management where they can be used as potential firebreaks or new needed access by the land owners. Overall, lines 5, 8, 12 and 15 may only be undertaken if approved and agreed with the surface land rights holders in the area.

The proposed 2D seismic survey will be conducted along existing roads, farm fences boundaries and tracks being used daily by local people and visitors within the survey area as well as along proposed new cutlines. 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.

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.

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 6.20.

Plate 6.1: 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 low raised vehicles to pass through the same tracks.

Table 6.20: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on the existing infrastructure, current and future land uses.

Influence of the proposed 2D seismic survey on the current and future land uses coexistence and potential land use conflicts	*Status*	Negative
	Probability	Probable; the use of supporting infrastructure areas such access road for the proposed survey will coexist with the local uses and no land use conflicts are envisaged.
	Confidence	High
	Extent	Local
	Duration	Long-term
	Intensity	Mild
	Significance	Medium to low

6.4.3.11 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 existing roads, farm fences boundaries and tracks as well as land owner approved new cutlines thereby minimising the overall likely negative impacts on the local ecosystem linked to regional and international ecosystems. Table 6.21 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 or passive use.

Table 6.21: 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.

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	*Status*	Negative
	Probability	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.
	Confidence	High
	Extent	Local (within 5 km of project area)
	Duration	Long-term
	Intensity	Mild
	Significance	Low

6.4.3.12 Physiography and Geology

The undulating forested Kalahari dune belt and the local Ephemeral River channels 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, farm fences boundaries 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 6.1). Soils along the Ephemeral River Channels are likely to be more susceptible to compaction and surface water ponding during the rainy season due to their higher clay contents. 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 in PEL 93 and AOI with variable yield and water quality, and.

(v) The Karoo flood Basalts, dyke swarms and sills underlies much of the Owambo (Etosha) Basin.

The likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on the physiography and geology are summarised in Table 6.22.

Table 6.22: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on the physiography and geology.

Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on the physiography and geology	*Status*	Negative
	Probability	Improbable
	Confidence	High
	Extent	Site-Specific
	Duration	Very short
	Intensity	Mild
	Significance	Low

6.4.3.13 Visual and Land Degradation along Survey Lines

It is anticipated that there will be some minor and limited impacts on the aesthetics of the local environment especially around the fly-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 (30-60 km/h) 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.

Fly-camp 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 and cutting of the firebreaks 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 6.23.

Table 6.23: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities with respect to visual and land degradation.

Visual effects and land degradation of the fly-campsite and survey vehicles along public roads / community areas and tracks resulting in land degradation	*Status*	Negative
	Probability	Improbable
	Confidence	High
	Extent	Site-specific
	Duration	Very short term
	Intensity	Mild
	Significance	Low

6.4.3.14 Water and Infrastructure Vulnerability Assessments and Access Water

According to Fig. 5.17, the proposed 2D seismic survey operations cover the following key aquifers in the region:

- Etosha Limestone Aquifer (KEL) covered by the AOI00.
- Oshivelo Multi-layered Aquifer (KOV) covered by the AOI00, AOI01, and AOI02, and.
- Ohangwena Multi-layered Aquifer (KOH) covered by the AOI01 and AOI02.

Table 6.24 shows the aquifer systems covered by the AOI00, AOI01 and AOI02, type of rocks, general water depth, quality, and yield for each of the three (3) Etosha Cuvelai Basins covered by the proposed 2D seismic survey operations as shown in Fig. 5.17.

Table 6.24: AOI00, AOI01 and AOI02, type of rocks, general water depth, quality, and yield for each of the three (3) Etosha Cuvelai Basins covered by the proposed 2D seismic survey operations (Modified from: Raison, 2011, www.bgr.bund.de).

AOI	Aquifer system	Rock type	Depth (m)	Quality	Yield (m^3/h)
02 and 01	Ohangwena multi-layered aquifer	Sand, sandstone	60-300	Fresh to brackish	1-50
02, 01& 00	Oshivelo multi-layered aquifer	Conglomerate, sandstone, sand, dolocrete, calcrete	30-150	Fresh to brackish	5-100
00	Etosha limestone aquifer	Dolocrete, calcrete, sand	10-100	Fresh, locally high Nitrates	3-100

The proposed 2D 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 fly-camp site areas. The overall water vulnerability to pollution because of the proposed activities as well as other existing activities is moderate to high. All the three (3) local aquifers in the area as shown in Table 6.24 are very porous and discharge of wastewater or chemicals/ oils into the ground without any form of engineered barrier or containment 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 860 or Vibroseis Truck such as the Nomad 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, farm fence boundaries and tracks as well as possible new cutlines subject to the approval of the land owners 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 the existing accesses were constructed using very heavy compacting road construction equipment.

Additionally, the existing access with water infrastructure nearby 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, Kavango West Region in 2017 and in PEL 93 Kavango East and West in 2021. No local community water wells or boreholes have been damaged by these surveys. Nonetheless, it is hereby recommended that a hydrocensus survey be undertaken prior to the implementation of the proposed project activities to have accurate locations and applicable offset/ setback distances around each of the water wells and boreholes as well as associated water infrastructure situated along the proposed seismic survey lines. 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 6.25 - 6.27.

Table 6.25: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on the surface and groundwater quality.

Likely negative physical impacts on the surface and groundwater quality along the proposed survey lines (existing roads, farm fence boundaries and tracks as well as possible new cutlines subject to the approval of the land owners) because of the proposed 2D seismic survey operations	*Status*	Negative
	Probability	Improbable
	Confidence	High
	Extent	Site-Specific
	Duration	Very short
	Intensity	Mild
	Significance	Low

Table 6.26: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on increased water consumption / depletion of water resources.

Depletion of water resources due to. increased water consumption / during the proposed 2D seismic survey activities	*Status*	Negative
	Probability	Definite
	Confidence	High
	Extent	Site specific
	Duration	Very short
	Intensity	Mild
	Significance	Low

Table 6.27: 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, farm fence boundaries and tracks as well as possible new cutlines subject to the approval of the land owners).

Likely negative physical impacts (damage) on the existing local community water supply infrastructure along the proposed survey lines (existing roads farm fence boundaries and tracks as well as possible new cutlines subject to the approval of the land owners).	*Status*	Negative
	Probability	Negligible
	Confidence	High
	Extent	Site specific
	Duration	Very short term
	Intensity	Mild
	Significance	Low

6.4.3.15 Security, Public Safety, Occupational Health, and Safety

Security, public safety, occupational health, and safety security is a major concern and are all very important components 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 6.28 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 6.28: 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.

Security, public safety, occupational health, and safety of the proposed 2D seismic survey operations on the local people and workers	*Status*	Negative
	Probability	Improbable; Addition to the already existing structures and disturbed land
	Confidence	High
	Extent	Local (within 5 km of project area)
	Duration	Long-term
	Intensity	Mild
	Significance	Low

6.4.3.16 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 hearing protection over an 8-hour 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 hearing protection equipment.

Some noise sensitive areas (e.g. Conservancies, national parks, 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 the 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 are also not going to 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 sparse population of the local area with limited fauna, the likely effects of the noise and vibrations that may be associated with the proposed 2D seismic survey operations will be low, localised and over a short period (Table 6.29).

Table 6.29: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities with respect to noise and vibrations.

The survey equipment and all the supporting vehicles at the campsites 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	*Status*	Negative
	Probability	Improbable
	Confidence	Medium
	Extent	Site-specific
	Duration	Very Short
	Intensity	Negligible
	Significance	Low

6.4.3.17 Dust and Air Quality

The proposed 2D seismic survey operations are 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 fly-camp sites. Likely localised air quality impacts may be associated with limited and few traffic movements and the likely negative effects will be negligible (Table 6.30).

Table 6.30: Likely negative environmental impacts assessment results of the proposed 2D seismic survey activities on dust and air quality.

Proposed 2D seismic survey operations likely dust generation and influences on the air quality.	*Status*	Negative
	Probability	Improbable
	Confidence	Medium
	Extent	Site-specific
	Duration	Very Short
	Intensity	Negligible
	Significance	Low

6.4.3.18 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 main campsite to be established at an existing lodging facility within PEL 93 and at fly-camps to be established for 1-2 weeks along the survey lines/ profiles (Plate 6.2). The fly-campsite will be equipped to handle both the liquid and solid waste likely to be generated. Each of the fly-campsites to be established along the profiles/ survey lines with the permission of the land owners will be equipped with chemical toilets. 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.

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. Burial of solid waste around the campsite, along the survey lines or anywhere within or outside the PEL area is prohibited and all hazardous materials such as oil shall be disposed off at an appropriate facility such as the Dundee Precious Metals Tsumeb private facility in Tsumeb. All domestic solid waste collected at the campsite and along the survey lines / profiles shall be disposed at an approved local authority facility north of Oshivelo (Plate 6.3). Continuous debriefing and awareness of the survey team on all matters related to environmental, solid, liquid waste and litter management must be undertaken. 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 6.31.

Table 6.31: Likely negative environmental impacts assessment results of the proposed 2D seismic survey with respect to waste (solid and liquid) management.

Influence of the solid and liquid waste management practices around the campsite and survey lines with respect to the proposed 2D seismic survey operations	*Status*	Negative
	Probability	Improbable; Limited volumes with waste management procedures will be provided
	Confidence	Medium
	Extent	Local (<5 km)
	Duration	Very short term
	Intensity	Negligible
	Significance	Low

6.4.3.19 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 6.32 summarises the likely negative environmental impacts assessment results of the proposed 2D seismic survey with respect accidental events.

Table 6.32: Likely negative environmental impacts assessment results of the proposed 2D seismic survey with respect accidental events.

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	*Status*	Negative
	Probability	Improbable; ERP and equipment such as onsite firefighting equipment will be provided
	Confidence	Medium
	Extent	Site-specific
	Duration	Very Short
	Intensity	Mild
	Significance	Low

Plate 6.2: A typical fly-camp that will be set-up along the proposed seismic survey lines lasting for up week or more and to be set-up with the approval of the land owners.

Plate 6.3: Oshivelo waste disposal site situated about 8 km north of the settlement of Oshivelo.

6.4.3.20 Likely Impacts on Archaeological, Historical and Cultural Resources

The field survey has located several historic and ethnographic sites found within the proposed area for 2D seismic survey considered to be significant and sensitive (Tables 5.2 -54). Sensitive heritage localities within 1km of the proposed 2D seismic survey and within PEL 93 have been identified as listed in Table 5.4. The proposed 2D seismic survey lines to be undertaken along the existing roads, farm fence boundaries and tracks and along possible new cutlines will not likely affect local archaeological resources although existing disturbance of the areas through previous land-use systems and existing infrastructure development activities would or might have probably already compromised some of the sites if they existed.

However, as international operator, MEL shall adopted the Alberta Government of Canada Distance Requirements Exploration Directive 2006-15 as shown in Table 3.1 of this report and with additional guidelines as provided by the International Association of Geophysical Contractors (IAGC). According to the recommended setback distance of 50m (Table 3.1) from the sensitive heritage localities, even the 1km nearest sites are still far away from the planned 2D seismic survey lines operations and are unlikely to be negatively impacted by the proposed once-off drive through 2D seismic survey operations along the existing access. Where new cut line may be created with the permission of the land owner, such new cutlines shall take into considerations the locations of archaeological, historical and cultural resources with coordinates provided in Tables 5.2-54.

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 6.33 summarises the likely negative environmental impacts assessment results of the proposed 2D seismic survey on the archaeological, paleontological, and historical resources.

Table 6.33: Likely negative environmental impacts assessment results of the proposed 2D seismic survey on the archaeological resources.

Disturbance / damage of sites of archaeological, historical and/or cultural value during the proposed 2D seismic survey operations	*Status*	Negative
	Probability	Improbably (the Proposed 2D seismic survey will be conducted along existing roads and tracks as well as the planned firebreak cutlines with greater line offset potential due to the use of wireless receivers).
	Confidence	Low
	Extent	Site Specific
	Duration	Permanent
	Intensity	Very Severe; if archaeological artefacts, cultural or historical sites are destroyed
	Significance	Low

6.4.3.21 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 Climate Accords, adopted in 2015 and 26th UN Climate Change Conference of the Parties (COP26) that took place in Glasgow from 31st October – 13th November 2021 both have global commitment goals of limiting global warming to below 2°C (and ideally below 1.5°C) above pre-industrial levels. 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).

According to the 2021 Namibia's Updated Nationally Determined Contribution published by the Ministry of Environment, Forestry and Tourism, Namibia's mitigation commitment is in the form of a decrease in Greenhouse gasses (GHG) emissions compared to the Business as Usual (BAU) baseline over the 2015-2030 period. The 2021 updated national document presents an improvement in the commitment of the devotion of Namibia to meeting the Paris Agreement goal and following the road to net zero emissions by 2050. Namibia has committed to reducing its GHG emissions conditionally by at least 91% of its BAU scenario by reducing emissions by 21.996 $MtCo_2e$ (14%) unconditional part and 77% conditional part) in 2030 compared to BAU (24.167 $MtCo_2e$) (Republic of Namibia, 2021).

Adaption is still a relevant feature in Namibia and the country is considered one of the most vulnerable countries to the impacts of climate change (Republic of Namibia, 2021). The country is particularly vulnerable to flooding and droughts. According to the Republic of Namibia, (2021), Ministries with adaptation relevance proposed a total of 49 priority actions with agriculture, tourism and fisheries sectors being critical for adaptation. Several ministries have set goals for both youth and women's participation because gender-balanced training and the promotion of the youth and women are seen as relevant to the adaptation drive (Republic of Namibia, 2021).

Namibia is working towards reducing the effects of global warming on communities and sectors through short and long-term resilience and adaption strategies. In the energy sector, the national sustainable energy strategy of Namibia looks to introduce new emissions-reducing technologies and encourage healthier practices that are more energy efficient. According to the 2021 Namibia's Updated Nationally Determined Contribution published by the Ministry of Environment, Forestry and Tourism, the projected net cost of the Updated Nationally Determined Contribution (NDC) mitigation measures to be implemented in Namibia is expected to be approximately USD 3.61 billion by 2030 and more than USD 1.72 billion for adaptation targets, representing a total funding need of approximately USD 5.33 billion (or N$ 77 billion). To put this figure of N$ 77 billion into the current and as at February 2021 Namibian fiscal context as published by the Ministry of Finance, the total estimated revenue collected for the year amounted to N$ 52.9 billion against a budget of N$ 55.5 billion while the total estimated expenditure for the year amounted to N$ 72.1 billion. The budget deficit is estimated at about 9.7 percent of Gross Domestic Product (GDP) with total debt standing at 68.8% and debt servicing estimated at N$ 7.7 billion or 14% of revenue.

Based on the current fiscal standing of Namibia for 2021-2022 and beyond, it will be extremely challenging and impossible for the country to be able to finance the N$ 77 billion NDC mitigation budget measures by 2030 without heavily relying on drying-up and scarce handouts, donations, loans, and grants from developed countries. The current and envisaged green environmental financing models that are dependent on handouts, donations, loans, and grants from developed countries coupled with massive socioeconomic challenges and rural inherited 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 prosperity 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 its 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 the search for groundwater, geothermal energy, and minerals resources. The proposed 2D seismic survey inclusive of all the supporting activities such as the fly-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 negligible global significance.

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 Oshikoto and Ohangwena Regions.

The release of airborne particulate matter can result from various natural activities including driving along the gravel or sandy tracks as well as naturally windblown matter. It is important to note 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 and 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, with no long-term cumulative impacts following cessation of the proposed activities. Table 6.34 summarises the likely negative environmental impacts assessment results of the proposed 2D seismic survey with respect to the contributions to global Climate Change.

Table 6.34: Likely negative environmental impacts assessment results of the proposed 2D seismic survey with respect to the contributions to global Climate Change.

Contributions to climate change due to increased vehicles movements / equipment emissions during the proposed 2D seismic survey operations	*Status*	Negative
	Probability	Improbable: Unlikely due to very limited scale of the proposed 2D seismic survey operations
	Confidence	High
	Extent	Site-specific
	Duration	Very short-term
	Intensity	Low
	Significance	Negligible

6.4.3.22 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, forest, 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 or passive use, physiography and geological resources, water, and water supply infrastructure vulnerability within he 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 as well as the planned firebreak cutlines using wireless receivers 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 6.35 summarises the likely negative environmental impacts assessment results of the proposed 2D seismic survey with respect to the negative cumulative impacts.

Table 6.35: Likely negative environmental impacts assessment results of the proposed 2D seismic survey with respect to cumulative impacts.

Proposed 2D seismic survey cumulative impacts on the habitats, fauna, and flora species, ecosystem functions, services, use values and non-use or passive use, physiography and geological resources, water, and water supply infrastructure vulnerability and other components of the receiving environment	*Status*	Negative
	Probability	Improbable
	Confidence	Medium to High
	Extent	Site-specific
	Duration	Very short
	Intensity	Low
	Significance	Low

6.4.4 Overall Individual Components and Significant Impact Assessment Results

6.4.4.1 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 the form of a matrix table shown in Table 6.36. The overall assessment is based on the grading of the impact assessment results of the individual components of the receiving environment as shown in Tables 6.3- 6.11 (positive impacts) and Tables 6.12-6.23 and Tables 6.25-6.35 (negative impacts).

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 process with each major step requiring a new environmental assessment process.

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 components of the receiving environment as may be applicable against the results of the exploration success. The implementation of the subsequent stage/s of exploration will be subject to the positive outcomes of previous activities as graded.

6.4.4.2 Assessment Results of the Overall Significant Impacts

The 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 receptors. Overall, the assessment of significant impacts has focused on the ecosystem-based approach that considers

potential impacts to the overall 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 covering the following key areas:

- 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 results of the significant impact assessment for the proposed 2D seismic survey are shown in Tables 6.37. It is important to note that the assessment of the likely impacts as shown in Tables 6.3-6.11 (positive impacts) and Tables 6.12-6.23 and Tables 6.25-6.35 (negative impacts) have been considered without the implementation of mitigation measures detailed in the separate EMP Report.

The need for implementation of the appropriate mitigation measures as presented in the EMP Report have been determined based on the results of the impact assessment Tables 6.3- 6.11 (positive impacts) and Tables 6.12-6.23 and Tables 6.25-6.35 (negative impacts) and the significant impacts as detailed in Table 6.37.

Table 6.36: 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.

RECEIVING ENVIRONMENT SENSITIVITY

SENSITIVITY RATING		CRITERIA
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.

				PHYSICAL ENVIRONMENT						BIOLOGICAL ENVIRONMENT					SOCIOECONOMIC, CULTURAL, AND ARCHAEOLOGICAL ENVIRONMENT				
				Water Quality	Physical infrastructure and Resources	Air Quality, Noise and Dust	Landscape Topography	Soil Quality	Climate Change Influences	Habitat	Protected Areas	Flora	Fauna	Ecosystem functions, services, use values and non-Use or passive use	Local, regional, and national socioeconomic settings	Subsistence Agriculture	Community Forest	Tourism and Recreation	Cultural, Biological and Archaeological Resources
SOURCES OF POTENTIAL IMPACT	**ROUTINE AND PHYSICAL PRESENCE OPERATIONAL ACTIVITIES**	1.	Planning and mobilisation (Pre-survey preparation, field scouting and mapping of buffers and offsets along proposed survey lines)	2	2	2	2	2	1	2	1	2	2	2	2	2	2	1	1
		2.	Base camp and fly-camps site setups and operations	2	2	2	2	2	1	2	1	2	2	2	2	2	2	1	1
		3.	Widening of tracks by pruning vegetation overgrowth and tracks levelling as may be applicable	2	2	2	2	2	1	2	1	3	2	2	2	2	2	1	1
		4.	Creation of new access especially cutting of new cutlines with the permissions of the land owners to be used for data acquisition	2	2	2	2	2	1	3	3	3	2	2	2	2	2	1	1
		5.	Actual survey operation (data acquisition).	2	2	2	2	2	1	2	1	2	2	2	2	2	2	1	1
		6.	Demobilisation and closure (Survey Completion)	2	2	2	2	2	1	2	1	2	2	2	2	2	2	1	1
	UNPLANNED ACCIDENTAL EVENTS	7.	Any accidental event that may be associated with the routine and physical presence operational activities	2	2	2	2	2	1	2	1	2	2	2	2	2	2	1	1

Table 6.37: 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.

IMPACT SEVERITY (Magnitude, Duration, Extent, Probability)	RECEPTOR CHARACTERISTICS (SENSITIVITY)				
	Very High (5)	High(4)	Medium (3)	Low (2)	Negligible (1)
Very High (5)	Major [5/5]	Major [4/5]	Moderate [3/5]	Moderate [2 /5]	Minor 1/5
High (4)	Major [5/4]	Major [4/4]	Moderate [3/4]	Moderate [2/4]	Minor[1/4]
Medium (3)	Major [5/3]	Moderate[4/3]	Moderate[3/3]	Minor[2/3]	None[1/3]
Low (2)	Moderate [5/2]	Moderate[4/2]	Minor[3/2]	None[2/2]	None[1/2]
Negligible (1)	Minor [5/1]	Minor [4/1]	None [3/1]	None [2/1]	None [1/1]

SOURCES OF POTENTIAL IMPACT				PHYSICAL ENVIRONMENT						BIOLOGICAL ENVIRONMENT					SOCIOECONOMIC, CULTURAL, AND ARCHAEOLOGICAL ENVIRONMENT				
				Water Quality	Physical infrastructure and Resources	Air Quality, Noise and Dust	Landscape Topography	Soil Quality	Climate Change Influences	Habitat	Protected Areas	Flora	Fauna	Ecosystem functions, services, use values and non-Use or passive use	Local, regional, and national socioeconomic settings	Subsistence Agriculture	Community Forest	Tourism and Recreation	Cultural, Biological and Archaeological Resources
ROUTINE AND PHYSICAL PRESENCE OPERATIONAL ACTIVITIES		1.	Planning and mobilisation (Pre-survey preparation, field scouting and mapping of buffers and offsets along proposed survey lines)	2/2	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	2/2	1/2
		2.	Base camp and fly-camps site setups and operations	2/2	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	2/2	1/2
		3.	Widening of tracks by pruning vegetation overgrowth and tracks levelling as may be applicable	2/2	2/2	2/2	2/2	2/2	1/2	2/2	1/2	3/2	2/2	2/2	2/2	2/2	2/2	2/2	1/2
		4.	Creation of new access especially cutting of new cutlines with the permissions of the land owners to be used for data acquisition	2/2	2/2	2/2	2/2	2/2	1/2	2/2	3/2	3/3	2/2	2/2	2/2	2/2	2/2	2/2	1/2
		5.	Actual survey operation (data acquisition).	2/2	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	2/2	1/2
		6.	Demobilisation and closure (Survey Completion)	2/2	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	2/2	1/2
UNPLANNED ACCIDENTAL EVENTS		7.	Any accidental event that may be associated with the routine and physical presence operational activities	2/2	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	2/2	1/2

7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Conclusions

MEL, the Proponent and Operator holds petroleum exploration rights under PEL 93 situated in northern Namibia. As part of its exploration commitments with the Namibian Government, the Proponent intends to conduct approximately 576 km long of 2D seismic survey activities aimed at delineating geological subsurface structures that could hold potential economic oil and gas resources. Except for 105 km lines comprising lines 5, 8, 12 and 15 that will require new cutlines to be created and subject to the approval or request of the land owners, the rest of the other proposed survey lines will be conducted along existing roads, tracks, and farm boundary fences. The Proponent intends to use either the Explorer 860 Accelerated Weight Drop (AWD) or vibroseis trucks such as the Nomad 65 Vibrator as the energy source with wireless receivers to allow for greater lines offset.

Onshore seismic survey operations have been undertaken in Namibia before and the latest being the 2021 completed and 2022 ongoing 2D seismic survey operations by ReconAfrica in PEL 73 covering Kavango West and East Regions. During any oil and gas exploration programmes, 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, farm boundary fences and tracks as well as along new cutlines if approved or requested by the land owners. 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 development options. 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 is implemented for the production phase of any discovered oil or gas resources.

Overall, 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.

Receptors likely to be negatively impacted at a local scale and especially during the creation any new cutlines as may be approved or requested by the land owners are: Habitats, reptiles, amphibians, mammals, avian, tree, shrub species and grass. The actual sites where expansion of the new cutlines 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. The likely limited negative impacts would include dust, noise, light, and other associated disturbances in the area, but be limited to the access clearing and seismic activity periods. This however, would depend on control over the contractors during the process of cutting the cutlines, but should be limited to localised implications.

The Proposed 2D seismic survey will have limited 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, farm fence boundaries and tracks with new cutlines to be created only on request or approval by the land owners.

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 seismic survey activities on the receiving environment (physical, socioeconomic, and biological) will likely be low and localised with negligible significant impact.

7.2 Recommendations

The following is a summary of recommendations to be implemented by the Proponent with respect to the key selected proposed project components:

(i) Project Location (PEL and AOI): The locations of the AOI within PEL 93 and the proposed profiles / survey lines are based on the assessment of the existing geological, geophysical, and other historical data sets covering the Owambo (Etosha) Sedimentary Basin. MEL has used the existing historical data sets to develop the theatrical hydrocarbon model that assumes the presence of potential oil reservoirs to be defined by the proposed 2D seismic survey operations and validated by possible drilling operations on site-specific locations that may be delineated by the 2D seismic survey data interpretation.

Detailed field-based survey / scouting activities were undertaken by the Proponent and verified by Risk-Based Solutions team between January and March 2022 in order to assess the field-based condition and take into considerations other existing alternative profiles routes. Most of the proposed survey lines will follow already existing roads, farm fence boundaries and tracks.

The Proponent may create new 105 km long cutlines for lines 5, 8, 12 and 15 only if approved or requested by the land owners / surface rights holder and only if such new cutlines will provide positive contributions to the land management strategies such as firebreak or needed for new access. 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 to be cut unnecessarily along the proposed survey lines and fly-camp areas. Various alternative tracks, roads, already disturbed areas, and village footpaths 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) Base Camp: Accommodation for the exploration team will be provided at an existing lodge nearest to the operational areas covering AOI00, AOI01 and AOI02.

(iii) Fly-camps: Fly-campsites along the selected survey lines shall be situated on already disturbed areas such as an unused previous agricultural field after obtaining written permission and signing of a formal Lease Agreement / Consent 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. Bottled drinking water shall be provided around the campsite and along the survey lines / profiles.

(v) Source of domestic energy requirements at the fly-campsites 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 fly-campsite and along the survey lines / profiles.

(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 base and fly-campsites and along the survey lines / profiles. Collected waste from the fly-camp and along the survey lines shall be disposed off at approved waste disposal sites. Littering around the base and fly-campsites 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 at each 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 frauds 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 seismic survey over the key Areas of Interest (AOI) in PEL No. 93 shall be granted with an Environmental Clearance Certificate (ECC) with the following key conditions:

(i) The proposed 2D seismic survey shall be undertaken in line with the provisions of the EMP, conditions of the Environmental Clearance Certificate (ECC) to be granted by the Environmental Commissioner, national and international environmental best practices, standards, and guidelines.

(ii) The Proponent shall adhere to the provisions of all the national legislation, regulations, policies, procedures, permits / authorisation requirements provisions of the EMP and mitigation measures shall be implemented, monitored and reported to the regulators as may be applicable or required by law.

(iii) Before the implementation of the proposed 2D seismic survey operations, the Proponent shall consult with the local community / owners of the private and communal land and villages that may be affected or likely to be disturbed by the proposed project activities. All the consultations and engagements shall be undertaken through the existing regional and local structures starting with the Office of the Governors for Oshikoto Region within which all the AOI falls, Councillors, Traditional Authorities, Village Headpersons, and Village Development Committees (VDCs), local community levels and private commercial farm owners.

(iv) Before any form of field-based activities are started in a local area, written consent shall always be obtained from the land owners. For communal land areas consent shall be obtained through the village headperson, traditional authorities, and regional council as may be applicable to avoid misunderstanding and unnecessary conflicts.

(v) Appropriate setback distances (exclusion zones) around sensitive structures such as villages, boreholes, water wells, dams, pipelines, burial grounds, cultural sites, irrigation canals and monuments / archaeological resources sites shall always be observed as provided for by the International Association of Geophysical Contractors (IAGC) the Distance Requirements Exploration Directive 2006-15, Alberta Government, Canada guidelines.

(vi) During the 2D seismic survey operations, MEL shall employ Local Community Liaison Officers (LCLO) from the local area to coordinate communications, consultations and engagement activities with the local land owners and communities.

(vii) A field-based wildlife expert shall also be employed to monitor wildlife activities with respect to the survey activities along the seismic survey lines before, during and after the survey operations and work with other local researchers and MEFT personnel in region working on wildlife related monitoring activities, and.

(viii) Precautionary principles / approaches shall always be exercised especially in situations where specific mitigations, regulatory guidelines, standards, or appropriate setback distances (exclusion zones) around sensitive local cultural resources such as burial or cultural sites have not been provided. Local communities shall always be consulted on matters related to sensitive local cultural resources not provided for in the national or international guidelines / standards.

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9. ANNEXES

1. **Final Environmental Scoping / BID Report Vol. 1 of 3**
2. **Fauna and Flora Specialist Report**
3. **Socioeconomic Assessment Desktop Report**
4. **Archaeological and Heritage Report**
5. **Public and stakeholder consultation materials**
6. **CVs of the EAP and Specialist Consultants**

Annex 1: Final Scoping Report (Not Attached) Submitted Separately

VERTEBRATE FAUNA AND FLORA ASSOCIATED WITH THE THE PEL 93 SEISMIC SURVEY AREA, OSHIKOTO REGION
[Baseline Study]

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CONTENTS

Vertebrate fauna and flora associated with the PEL 93 Seismic Survey area, Oshikoto Region

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 Oshikoto Region – AOI00; AOI01 & AOI02 [Blocks 1717 & 1817; PEL 93] – was conducted during February 2022. This was followed up by fieldwork conducted between 4-7 March 2022 (current study) to determine the effect that the proposed ground seismic survey, using surface weight drop with Explorer 860 truck as source unit or Vibroseis with a Nomad 65 Vibrator, may have on the bio-physical environment (vertebrate fauna and flora) within the development area and immediate surroundings (especially along the general proposed seismic survey line areas) (Figure 1).

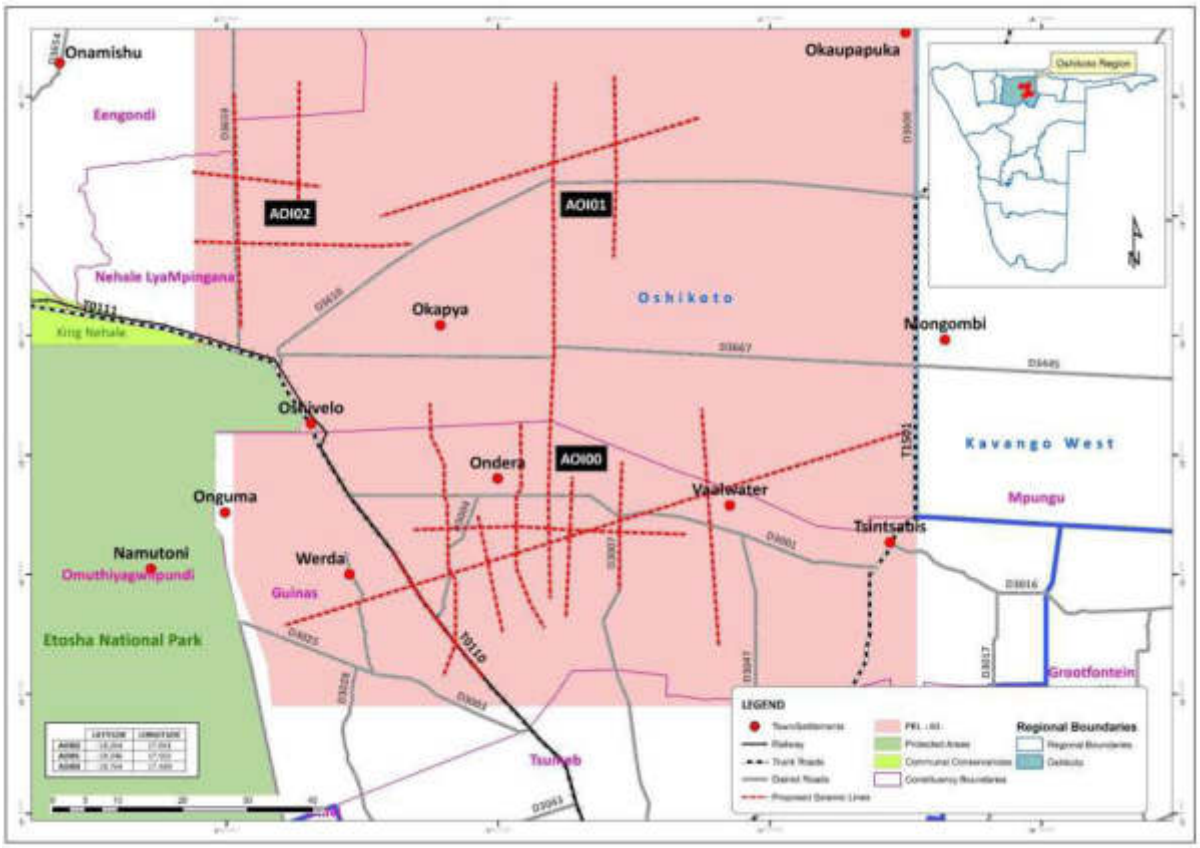

Figure 1. The locations of the proposed seismic survey lines within PEL 93 (AOI00; AOI01 & AOI02), located roughly between Tsumeb-Tsintsabis-Oshivelo-Omuthiya (red dotted lines) (Risk Based Solutions).

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 ephemeral drainage line is the Omuramba Owambo which meanders from east to west and enters the Etosha Pan at Fishers Pan within the Etosha National Park followed by the ephemeral Omuthiya River which roughly follows the same course, albeit slightly to the north of the Omuramba Owambo. The Cuvelai Basin and Etosha Pans have known distinctive values which include biotic richness, important ephemeral pan habitat; breeding red data birds; resources for people and a significant basis of Namibia's tourism industry (Curtis and Barnard 1998).

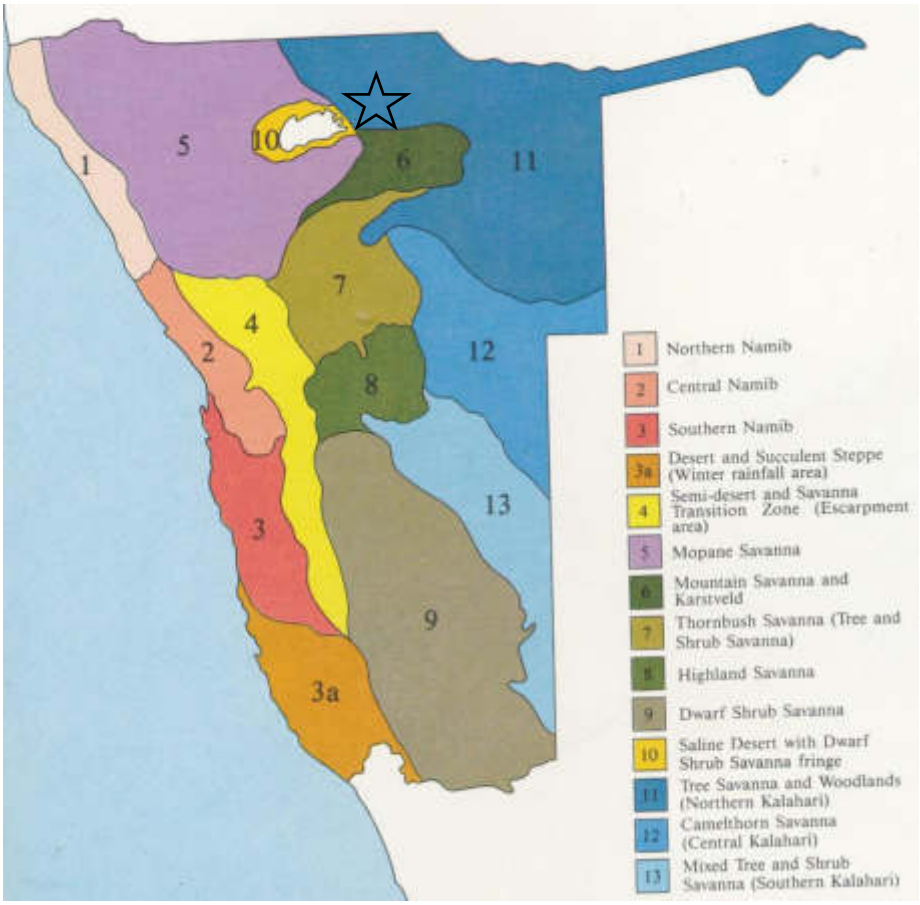

Figure 2. The Seismic Surveys within the PEL 93 area, falls within the Tree Savanna and Woodlands (Northern Kalahari) vegetation type (Giess 1971) (black star).

The Woodland Biome – of which the PEL 93 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 area is the Etosha National Park (22,270km^2) which was proclaimed in 1907 (See www.met.gov.na).

The AOI00 falls mainly within freehold farming areas between Tsumeb-Oshivelo-Tsintsabis while the AOI01 & AOI02 fall within the Owambo communal area north of Oshivelo (AOI = Areas of Interest). The closest communal conservancy to the AOI is the King Nehale conservancy located on the northeastern boundary of the Etosha National Park and Okongo to the north (MEFT/NACSO 2021, See: www.nacso.org.na) while the closest community forests are Ohepi (to the northwest) and Okongo and Omufitu Wekuta (to the north) (See: See: www.nacso.org.na). There are no freehold (commercial) conservancies in the area with the closest being the Etosha Conservancy located to the southwest and west of Tsumeb (Mendelsohn *et al.* 2002, See: www.canam.iway.na).

The general area is regarded as “high” in overall (all terrestrial species) diversity (Mendelsohn *et al.* 2002). Overall terrestrial endemism – all species – in the area on the other hand is “medium to high” (Mendelsohn *et al.* 2002). The overall diversity and abundance of large herbivorous mammals (big game) is viewed as “low to average” with oryx and kudu dominant especially in the freehold farming areas while the overall diversity and density of large carnivorous mammals (large predators) is determined as “average” with 1-3 species expected – e.g. leopard and cheetah having the low to medium densities (Mendelsohn *et al.* 2002).

It is estimated that at least 65 species of reptile, 17 amphibian, 97 mammal and 250 bird species (breeding residents) are known to or expected to occur in the general 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 – approximately 687 species in total – are manly 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 *Anthephora 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 150-399 species although the Karst areas around Tsumeb have >500 species). The plant endemism is viewed as “low” throughout with only 1 species viewed as endemic (Mendelsohn *et al.* 2002). Simmons (1998a) puts the plant endemism in the general area at between 1-20 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 “low” (5-10%) although dependant on the location.

The grazing potential is viewed as “high” in the general area while the browse potential is viewed as “good”. Bush thickening (encroachment) is viewed as problematic in the general area with *Dichrostachys cinerea* (4,000-12,000 plants/ha) and *Colophospermum mopane* 2,000-3,000plants/ha) (Bester 1996, Cunningham 1998). The risk of farming is viewed as “low” with the tourism potential viewed as “high” (Mendelsohn *et al.* 2002).

It is estimated that at least 95 species of larger trees and shrubs (>1m in height) and up to 116 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 84).

2.2 Field Survey

Vertebrate fauna
According to the original ToR, a rapid fieldwork assessment was conducted between 4 and 7 March 2022 to determine the actual faunal diversity and would include the following:

- Mammal presence will be determined in the area;
- Reptile & amphibian transects (diurnal) to determine reptile & amphibian diversity in the area;
- Bird transects to determine avian diversity in the area; and
- Flora transects to determine plant diversity in the area.

[The focus of the surveys would be in the general areas identified as the "seismic survey lines" – i.e. general AOI]

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

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
Assessing 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 – species composition
- Grasses – 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). The vegetation assessments were conducted at the following points along various vehicle routes in the general AOI:

AOI00 (every 5km)

- 18°42'24.9" & 17°12'53.8" [D3001] 1
- 18°42'25.3" & 17°15'38.1" [D3001] 2
- 18°42'25.8" & 17°18'24.0" [D3001] 3
- 18°42'26.3" & 17°21'09.5" [D3001] 4
- 18°42'26.2" & 17°23'54.8" [D3001] 5
- 18°42'26.0" & 17°26'39.8" [D3001] 6
- 18°42'26.1" & 17°29'25.4" [D3001] 7
- 18°42'26.5" & 17°32'11.2" [D3001] 8
- 18°43'37.7" & 17°34'31.4" [D3001] 9
- 18°43'53.1" & 17°37'03.8" [D3001] 10
- 18°44'08.9" & 17°39'48.1" [D3001] 11
- 18°44'48.0" & 17°42'29.4" [D3001] 12
- 18°45'32.2" & 17°45'07.7" [D3001] 13
- 18°46'30.2" & 17°47'41.4" [D3001] 14
- 18°44'59.1" & 17°22'39.4" [D3004] 1
- 18°47'01.3" & 17°21'07.9" [D3004] 2
- 18°49'48.2" & 17°21'07.2" [D3004] 3
- 18°52'06.4" & 17°20'32.9" [D3004] 4
- 18°46'52.9" & 17°35'23.1" [D3007] 1
- 18°49'31.6" & 17°35'22.3" [D3007] 2
- 18°52'01.7" & 17°34'25.4" [D3007] 3
- 18°54'25.3" & 17°34'23.6" [D3007] 4
- 18°48'14.9" & 17°46'07.4" [D3047] 1
- 18°50'48.6" & 17°46'40.4" [D3047] 2
- 18°53'27.6" & 17°46'40.3" [D3047] 3
- 18°56'06.6" & 17°46'40.3" [D3047] 4
- 18°47'01.7" & 17°12'53.1" [C38] 1
- 18°47'47.7" & 17°10'22.5" [C38] 2
- 18°48'20.2" & 17°07'37.3" [C38] 3
- 18°48'16.2" & 17°04'52.3" [C38] 4

AOI01 (every 10km)

- 18°28'02.5" & 17°09'51.2" [D3610] 1
- 18°24'47.6" & 17°14'12.1" [D3610] 2
- 18°21'42.8" & 17°18'38.3" [D3610] 3
- 18°19'10.7" & 17°23'26.2" [D3610] 4
- 18°16'46.1" & 17°28'19.1" [D3610] 5
- 18°16'22.6" & 17°33'43.7" [D3610] 6
- 18°16'18.2" & 17°39'08.6" [D3610] 7
- 18°16'18.5" & 17°44'36.9" [D3610] 8

AOI02 (every 5km)

- 18°27'51.3" & 17°03'41.1" [D3659] 1
- 18°25'13.0" & 17°03'34.5" [D3659] 2
- 18°22'35.9" & 17°03'27.0" [D3659] 3
- 18°19'58.2" & 17°03'22.9" [D3659] 4
- 18°17'20.7" & 17°03'19.2" [D3659] 5

- 18°14'42.1" & 17°03'16.9" [D3659] 6
- 18°12'05.0" & 17°03'16.7" [D3659] 7
- 18°09'25.3" & 17°03'16.5" [D3659] 8

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.

3 Results

3.1 Reptile Diversity

Reptile diversity known and/or expected to occur in the general PEL 93 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 61-80 species and 5-8 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 21-30 and 41-50 for indigenous lizards and snakes, respectively. The closest Government protected area – Etosha National Park – has an estimated 109 species of reptiles (Griffin 1998a).

At least 65 species of reptiles are expected to occur in the general area with 9 species being endemic (i.e. 13.9% endemic). Two species are viewed as rare (*Gonionotophis (Mehelya) vernayi*, *Sepsina angolensis*); 4 species as vulnerable (*Stigmochelys pardalis*, *Psammobates oculiferus*, *Python natalensis*, *Varanus albigularis*); 4 species as protected game (*Stigmochelys pardalis*, *Psammobates oculiferus*, *Python natalensis*, *Varanus albigularis*); 1 species as insufficiently known (*Gonionotophis (Mehelya) vernayi*) 1 species as indeterminate (*Sepsina angolensis*) and 3 species as peripheral. All the other species are classified as "secure". Twenty species have some form of international conservation status – i.e. IUCN (2021) lists 17 species as least (all other species have not yet been assessed by the IUCN Red List); SARDB (2004) lists 2 species as vulnerable and 2 species as peripheral and CITES lists 5 species as C2 – i.e. Appendix 2 species. Some species have more than one conservation status.

The 65 species expected to occur in the general area consist of at least 2 tortoises (all vulnerable and protected game), 1 terrapin, 29 snakes (2 thread snake, 1 python, 1 burrowing snake, 2 quill snouted and 23 typical snakes) of which 1 species is classified as rare, 1 species as vulnerable and 4 species as endemic, 2 worm lizards, 8 skinks (of which 1 species is classified as rare), 7 old world lizards, 3 plated lizards, 1 monitor lizard, 2 agama, 1 chameleon and 7 geckos.

Snakes (29 species), skinks (8 species), geckos (7 species) are the most important groups of reptiles expected from the general area. Namibia with approximately 129 species of lizards

Table 1. Reptile diversity expected (literature study) and confirmed (fieldwork) including author's confirmed records from other studies conducted from the general area.

Species: Scientific name	Species: Common name	Species confirmed	Namibian conservation and legal status	International status		
				IUCN (2020)	SARDB (2004)	CITES
TURTLES AND TERRAPINS						
Stigmochelys pardalis	Leopard Tortoise	√;√*	Vulnerable; Peripheral; Protected Game	LC		C2
Psammobates oculiferus	Kalahari Tent Tortoise	√*	Vulnerable; Protected Game			C2
Pelomedusa subrufa	Marsh/Helmeted Terrapin	√*	Secure			
SNAKES						
Blind Snakes						
Rhinotyphlops schinzi	Schinz's Beaked Blind Snake		Endemic; Secure	LC	P	
Rhinotyphlops schlegelii petersii	Schlegel's Beaked Blind Snake		Secure			
Thread Snakes						
Leptotyphlops (scutifrons) merkeri	Peters' Thread Snake		Secure	LC		
Namibiana (Leptotyphlops) labialis	Damara Thread Snake		Endemic; Secure	LC		
Pythons						
Python natalensis	Southern African Python	√*	Vulnerable; Peripheral; Protected Game	LC	V	C2
Burrowing Asps						
Atractraspis bibronii	Bibron's Burrowing Asp		Secure			
Quill Snouted Snakes						
Xenocalamus bicolor bicolor	Bicoloured Quill-snouted Snake		Secure			
Xenocalamus mechowii	Elongate Quill-snouted Snake		Secure			
Typical Snakes						
Boaedon (Lamprophis) fuliginosus	Brown House Snake	√*	Secure	LC		
Lycophidion capense ornatum	Cape Wolf Snake		Secure			
Limaformosa (Mehelya) vernayi	Angola File Snake		Insufficiently known; Rare?	LC		
Pseudaspis cana	Mole Snake		Secure			
Prosymna angolensis	Angola Shovel-snout		Secure	LC		
Prosymna frontalis	South-western Shovel-snout		Endemic		P	
Psammophylax tritaeniatus	Striped Skaapsteker		Secure	LC		
Psammophistrigrammus	Western Sand Snake		Endemic; Secure			
Psammophis leightoni	Namib Fork-marked Sand Snake		Secure	LC		
Psammophis subtaeniatus	Stripe-bellied Sand Snake		Secure	LC		
Psammophis brevirostris leopardinus	Leopard/Short-snouted Grass Snake		Secure			

Species: Scientific name	Species: Common name	Species confirmed	Namibian conservation and legal status	International status		
				IUCN (2020)	SARDB (2004)	CITES
Psammophis mossambicus	Olive Grass Snake		Secure			
Philothamnus semivariegatus	Spotted Bush Snake		Secure			
Dasypeltis scabra	Common/Rhombic Egg Eater		Secure	LC		
Telescopus semiannulatus polystrictus	Eastern Tiger Snake		Secure			
Dispholidus typus	Boomslang	√*	Secure			
Thelotornis capensis oatesii	Twig/Vine Snake		Secure	LC		
Elapsoidea semiannulata	Angolan Garter Snake		Secure			
Naja anchietae anchietae	Snouted Cobra	√*	Secure			
Naja nigricincta	Black-necked Spitting Cobra	√*	Endemic; Secure			
Dendroaspis polylepis	Black Mamba	√*	Secure	LC		
Bitis arietans	Puff Adder	√*	Secure			
Bitis caudalis	Horned Adder		Secure			
Worm Lizard						
Zygaspis quadrifrons	Kalahari Round-headed Worm Lizard		Secure			
Monopeltis anchietae	Anchieta's Spade-snouted Worm Lizard		Secure	LC		
LIZARDS						
Skinks						
Sepsina angolensis	Angola Burrowing Skink		Indeterminate; Rare?			
Typhlacontias rohani	Kalahari Burrowing Skink		Secure			
Mochlus (Lygosoma) sundevallii	Sundevall's Writhing Skink		Secure	LC		
Trachylepis binotata	Owambo Tree Skink		Secure			
Trachylepis spilogaster	Kalahari Tree Skink		Secure			
Trachylepis striata wahlbergi	Striped Skink		Secure			
Trachylepis variegata punctulata	Variegated Skink		Secure			
Panaspis wahlbergii	Wahlberg's Snake-eyed Skink		Not listed			
Old World Lizards						
Heliobolus lugubris	Bushveld Lizard		Secure			
Ichnotropis capensis	Cape Rough-scaled Lizard		Secure			
Ichnotropis squamulosa	Common Rough-scaled Lizard		Secure			
Nucras intertexta	Spotted Sandveld Lizard		Secure			
Pedioplanis lineoocellata	Spotted Sand Lizard		Secure			
Pedioplanis namaquensis	Namaqua Sand Lizard		Secure			
Pedioplanis undata	Western Sand Lizard		Endemic; Secure			

Species: Scientific name	Species: Common name	Species confirmed	Namibian conservation and legal status	International status		
				IUCN (2020)	SARDB (2004)	CITES
Plated Lizards						
Zonosaurus (Gerrhosaurus) multilineatus	Kalahari Plated Lizard		Secure			
Zonosaurus (Gerrhosaurus) nigrolineatus	Black-lined Plated Lizard	√;√*	Secure			
Zonosaurus (Gerrhosaurus) validus maltzahni	Giant Plated Lizard		Secure			
Monitors						
Varanus albigularis	Rock or White-throated Monitor	√;√*	Vulnerable; Peripheral; Protected Game		V	C2
Agamas						
Agama aculeata aculeata	Ground Agama	√;√*	Secure			
Agama etoshae	Etosha Agama	√*	Endemic; Secure			
Chameleons						
Chamaeleo dilepis	Flap-neck Chameleon	√*	Secure	LC		C2
Geckos						
Colopus wahlbergii wahlbergii	Kalahari Ground Gecko		Secure			
Lygodactylus bradfieldi	Bradfield's Dwarf Gecko		Endemic; Secure			
Pachydactylus bicolor	Velvety Thick-toed Gecko		Endemic; Secure			
Pachydactylus capensis	Cape Thick-toed Gecko		Endemic; Secure			
Chondrodactylus (Pachydactylus) turneri	Turner's Thick-toed Gecko		Secure			
Pachydactylus punctatus	Speckled Thick-toed Gecko		Secure			
Pachydactylus weberi	Weber's Thick-toed Gecko		Secure			

Namibian conservation and legal status according to the Namibian Conservation Ordinance of 1975 (Griffin 2003)
"Endemic" include endemic species to South Africa (Branch 1998)
IUCN (2021) – International Union for the Conservation of Nature and Natural Resources [All species not listed by the IUCN (2021) have not yet been assessed for the IUCN Red List]. LC = Least Concern
SARDB (2004) – South African Red Data Book. V = Vulnerable; P = Peripheral
CITES – Convention on International Trade in Endangered Species of Wild Fauna and Flora C2 = CITES Appendix 2 species.
√* – Authors personal records from general area

Source for literature review: Alexander and Marais (2007), Branch (1998), Branch (2008), Boycott and Bourquin 2000, Broadley (1983), Buys and Buys (1983), Cunningham (2006), Griffin (1998a), Griffin (2003), Hebbard (n.d.), IUCN (2021), Marais (1992), SARDB (2004), Tolley and Burger (2007).

(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 4 species were confirmed along the various seismic survey routes assessed (Figure 3) and 15 species from the general area using the authors' previous records. This included 2 tortoises, 1 terrapin, 1 python, 6 typical snakes, 1 plated lizard, 1 monitors, 2 agama and 1 chameleon – i.e. a total of at least 15 species are confirmed from the general area – See Table 1. 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 and time spent in the field limited to various access routes and at various assessment points along these routes.

Figure 3. *Stigmochelys pardalis* (leopard tortoise) – vulnerable; peripheral; protected game; LC; C2 – juvenile observed crossing the D3007 in the AOI00.

The most important species are viewed as those with some form of conservation status (Namibian and International – See Table 1) 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 most important species know/expected to occur in the general area would be the 2 species classified as rare (*Gonionotophis (Mehelya) vernayi*, *Sepsina angolensis*); 4 species classified as vulnerable (*Stigmochelys pardalis*, *Psammobates oculiferus*, *Python natalensis*, *Varanus albigularis*); 4 species classified as protected game (*Stigmochelys pardalis*, *Psammobates oculiferus*, *Python natalensis*, *Varanus albigularis*); 1 species classified as insufficiently known (*Gonionotophis (Mehelya) vernayi*) and 1 species classified as indeterminate (*Sepsina angolensis*). 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 close to towns, villages and settlements such as Oshivelo, etc.; crop production and land clearing on freehold farms; subsistence farming activities in communal areas, etc. and none of the unique reptiles are expected to be exclusively associated with the seismic survey routes in AOI00, AOI01 and

AOI02. The proposed mitigations – See Section 4 – are expected to minimise the overall effect on reptiles potentially occurring in the area.

Impact of extension of seismic lines along existing roads/tracks:
A typical weight drop would have a peak force output of 860,000lbs (~430,000kg) at base plate 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.

A single vibrator truck can generate more than 178 N (Newton of ground force), and usually four trucks are clustered together to create the energy at each source point, creating a combined ground force of 667 to 890 kN (kilonewton of ground force). A seismic vibrator transforms the energy provided by a diesel engine into a vibration. It is performed by a shaker, a movable element that generates the vibration, thanks to a piston-reaction mass device driven by an electro hydraulic servo valve. The shaker is applied to the ground for each vibration and then raised up so that the seismic vibrator can move to another vibrating point. Vibroseis do not cause any disturbance except for the need to widen the track and for a light terrain vibration to be felt and read by the geophones – i.e. no explosives are required. 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 vibroseis 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, the extension of seismic line 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.

Impact of new seismic lines:
Habitat destruction would occur along new routes envisaged. The widening and upgrading of the existing sandy tracks is also expected to contribute to habitat destruction/alteration. Increased traffic along these new access routes 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. chameleon, tortoises and monitor lizards), etc.

3.2 Amphibian Diversity

Amphibian diversity known and/or expected to occur in the general PEL 93 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.

Species: Scientific name	Species: Common name	Namibian conservation and legal status	International status: IUCN (2021)
Rain Frogs			

Species: Scientific name	Species: Common name	Namibian conservation and legal status	International status: IUCN (2021)
Breviceps adspersus adspersus	Bushveld Rain Frog		LC
Toads			
Amietophrynus gutturalis	Guttural Toad		LC
Amietophrynus maculatus	Flat-backed Toad		LC
Amietophrynus poweri	Western Olive Toad		LC
Pygmy Toads			
Poyntonophrynus dombensis	Dombe Pygmy Toad		LC
Kassinas			
Kassina senegalensis	Bubbling Kassina		LC
Rubber Frog			
Phrynomantis affinis	Spotted Rubber Frog		LC
Phrynomantis bifasciatus	Banded Rubber Frog		LC
Puddle Frog			
Phrynobatrachus mababiensis	Dwarf Puddle Frog		LC
Phrynobatrachus natalensis	Snoring Puddle Frog		LC
Ornate Frogs			
Hildebrandtia ornata	Ornate Frog		LC
Platannas			
Xenopus laevis	Common Platanna		LC
Xenopus petersii	Peter's Platanna		LC
Cacos			
Cacosternum boettgeri	Boettger's Caco		LC
Bullfrogs			
Pyxicephalus adspersus	Giant Bullfrog		LC; NT*
Sand Frogs			
Tomopterna krugerensis	Knocking Sand Frog		LC
Tomopterna tandyi	Tandy's Sand Frog		LC

Namibian conservation and legal status according to the Namibian Conservation Ordinance of 1975 (Griffin 2003)
NT* = Near Threatened (Minter *et al.* 2004)
IUCN (2021) – International Union for the Conservation of Nature and Natural Resources; LC = Least Concern

Source for literature review: Carruthers (2001), Channing (2001), Channing and Griffin (1993), Du Preez and Carruthers (2009), Griffin (1998b), IUCN (2021), Passmore and Carruthers (1995).

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 12-15 species. Griffin (1998b) puts the species richness in the general area at 14-15 species. The closest Government protected area – Etosha National Park – has an estimated 18 species of amphibians (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 (2021) as it is consumed as food throughout its range (Griffin *pers. com.*). According to Simmons (1998a) 1 endemic species occurs in the area.

According to the literature, at least 17 species of amphibians can occur in suitable habitat in the general area. The area is under represented, with 1 rain frog, 3 toads, 1 pygmy toad, 1 kassina, 2 rubber frogs, 2 puddle frogs, 1 ornate frog, 2 platannas, 1 caco, 1 bullfrog and 2 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 after localised rain showers (Figure 4). The lack of amphibians observed during the fieldwork could mainly be ascribed to limited time on site and lack of surface water throughout a sand dominated area.

Figure 4. Water collects in small pans in the AOI01 after localised 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 (2021) as it is consumed as food throughout its range (Griffin *pers. com.*). Most amphibians are expected to be associated with the ephemeral Omuramba Owambo and Omuthiya and various smaller pans throughout the general area (Figure 5).

Figure 5. The ephemeral Omuramba Owambo flows through the area into the Etosha Pan and is viewed as the most important drainage line in the area.

The general area has been heavily impacted in places, especially close to towns, villages and settlements such as Oshivelo, etc.; crop production and land clearing on freehold farms; subsistence farming activities in communal areas, etc. and none of the unique amphibians are expected to be exclusively associated with the seismic survey routes in AOI00, AOI01 and AOI02. The proposed mitigations – See Section 4 – are expected to minimise the overall effect on amphibians potentially occurring in the area.

Impact of seismic activity and seismic lines along existing roads/tracks:
A typical weight drop would have a peak force output of 860,000lbs (~430,000kg) at base plate 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 Owambo (and other ephemeral drainage lines), is more important although the actual footprint is small. However, the extension of seismic line 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.

Impact of new seismic lines:
Habitat destruction would occur along new routes envisaged. The widening and upgrading of the existing sandy tracks is also expected to contribute to habitat destruction/alteration. Increased traffic along these new access routes 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 93 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*.

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 (Griffin 1998c).

The overall mammal diversity in the general area is estimated at between 61-90 species with 1-2 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 1-2 endemics occur in the area. The closest Government protected area – Etosha National Park – has an estimated 102 species of mammals (Griffin 1998c).

According to the literature at least 97 species of mammals are expected to occur in the general area although not all the species indicated in Table 3 are expected to be found throughout the AOI's.

Of the species expected to occur in the greater area, 4 species are viewed as rare (*Kerivoula lanosa*, *Zelotomys woosnami*, *Atelerix frontalis angolae*, *Civittictis civetta*), 2 species endangered (*Lycaon pictus*, *Equus (burchellii) quagga*), 14 species vulnerable, 4 species specially protected game, 17 species protected game, 4 species indeterminate, 8 species insufficiently known, 4 huntable game, 3 problem animals, 14 peripheral and 6 not listed under Namibian legislation (Griffin and Coetzee 2005). The IUCN (2021) classifies 2 species as endangered (*Loxodonta africana*, *Lycaon pictus*), 5 species as vulnerable (*Smutsia (Manis) temminckii*, *Acinonyx jubatus*, *Panthera pardus*, *Panthera leo*, *Aepyceros melampus petersi*) and 2 species as near threatened (*Macronycteris (Hipposideros) vittatus*, *Parahyaena (Hyaena) brunnea*). The SARDB (2004) classifies 1 species as endangered, 4 species as vulnerable, 12 species as near threatened and 5 species as data deficient while CITES lists 2 species as Appendix I and 9 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 north-central part of Namibia.

Table 3. Mammal diversity expected (literature study) and confirmed (fieldwork) including author's confirmed records from other studies conducted from the general area.

Species: Scientific name	Species: Common name	Species confirmed	Namibian conservation and legal status	International status:		
				SARDB (2004)	IUCN (2021)	CITES
Shrews						
Crosidura hirta	Lesser Red Musk Shrew		Secure			
Elephant Shrews						
Elephantulus intufi	Bushveld Elephant-shrew		Secure	DD		
Aardvark						
Orycteropus afer	Aardvark		Secure; Protected Game			
Elephant						
Loxodonta africana	African Savanna Elephant		Vulnerable; Specially Protected Game		E	C2
Bats						
Hipposideros caffer	Sundevall's Leaf-nosed Bat		Secure	DD		
Macronycteris (Hipposideros) gigas	Giant Leaf-nosed Bat		Not Listed (#NT)			
Macronycteris (Hipposideros) vittatus	Striped Leaf-nosed Bat		Not Listed		NT	
Rhinolophus darlingi	Darling's Horseshoe Bat		Secure	NT		
Rhinolophus denti	Dent's Horseshoe Bat		Secure (#DD)	NT		
Rhinolophus fumigatus	Rüppell's Horseshoe Bat		Secure	NT		
Taphozous mauritianus	Mauritian Tomb Bat		Secure			
Nycteris thebaica	Egyptian Slit-faced Bat		Secure			
Chaerephon ansorgei	Ansorge's Free-tailed Bat		Not Listed			
Chaerephon nigeriae	Nigerian Free-tailed Bat		Secure			
Mops midas	Midas Free-tailed Bat		Secure			
Tadarida aegyptiaca	Egyptian Free-tailed Bat		Secure			
Miniopterus natalensis	Natal Long-fingered Bat		Secure (#NT)	NT		
Eptesicus hottentotus	Long-tailed Serotine Bat		Secure			
Glauconycteris variegata	Butterfly Bat		Secure	NT		
Hypsugo (Pipistrellus) anchietae	Anchieta's Pipistrelle		Not Listed			
Kerivoula lanosa	Lesser Woolly Bat		Indeterminate; Rare?; Peripheral	NT		
Laephotis botswanae	Botswana Long-eared Bat		Secure	V		
Mimetillus thomasi	Thomas's Flat-headed Bat		Not Listed			
Neoromicia capensis	Cape Serotine Bat		Secure			

Species: Scientific name	Species: Common name	Species confirmed	Namibian conservation and legal status	International status:		
				SARDB (2004)	IUCN (2021)	CITES
Neoromicia nana	Banana Bat		Secure			
Neoromicia zuluensis	Zulu Serotine Bat		Secure			
Nycticeinops schlieffeni	Schlieffen's Twilight Bat		Secure			
Pipistrellus rueppellii	Rüppell's Pipistrelle		Insufficiently Known; Peripheral			
Pipistrellus rusticus	Rusty Pipistrelle		Secure	NT		
Scotophilus dinganii	Yellow-bellied House Bat		Secure			
Scotophilus leucogaster	White-bellied House Bat		Not Listed			
Monkeys, Baboons and Bushbaby						
Cercopithecus pygerrythrus	Vervet Monkey		Secure			C2
Papio ursinus	Chacma Baboon	√*	Secure; Problem Animal			C2
Galago moholi	South African Galago	√*	Vulnerable; Protected Game			C2
Pangolin						
Smutsia (Manis) temminckii	Pangolin		Vulnerable; Protected Game; Peripheral	V	V	C2
Hares and Rabbits						
Lepus saxatilis	Scrub Hare	√*	Secure			
Rodents						
Molerat						
Cryptomys (Fukomys) damarensis	Damaraland Mole-rat	√	Secure			
Porcupine, Springhare, Squirrel						
Hystrix africaeaustralis	Cape Porcupine		Secure			
Pedetes capensis	Springhare		Secure			
Xerus inaurus	South African Ground Squirrel		Secure			
Xerus princeps	Damara Ground Squirrel		Endemic	NT		
Funisciurus congicus	Striped Tree Squirrel	√*	Secure			
Dormice, Rats and Mice						
Graphiurus platyops	Rock Dormouse		Endemic; Secure	DD		
Graphiurus murinus	Woodland Dormouse		Secure			
Lemniscomys rosalia	Single-striped Grass Mouse		Secure	DD		
Rhabdomys pumilio	Four-striped Grass Mouse		Secure			
Zelotomys woosnami	Woosam's Desert Mouse		Rare			
Mus indutus	Desert Pygmy Mouse		Secure			
Mastomys natalensis	Natal Multimammate Mouse		Secure			
Mastomys coucha	Southern Multimammate Mouse		Secure			

Species: Scientific name	Species: Common name	Species confirmed	Namibian conservation and legal status	International status:		
				SARDB (2004)	IUCN (2021)	CITES
Thallomys paedulcus	Acacia Rat		Secure			
Thallomys nigricauda	Black-tailed Tree Rat		Secure			
Aethomys chrysophilus	Red Veld Rat		Secure			
Aethomys namaquensis	Namaqua Rock Mouse		Secure			
Desmodillus auricularis	Cape Short-tailed Gerbil		Secure			
Gerbillurus paeba	Hairy-footed Gerbil		Secure			
Tatera (Gerbilliscus) leucogaster	Bushveld Gerbil		Secure	DD		
Tatera (Gerbilliscus) brantsii	Highveld Gerbil		Secure			
Saccostomus campestris	Pouched Mouse		Secure			
Malacothrix typica	Gerbil Mouse		Secure			
Steatomys pratensis	Fat Mouse		Secure			
Steatomys parvus	Tiny Fat Mouse		Peripheral			
Petromyscus collinus	Pygmy Rock Mouse		Endemic; Secure			
Hedgehogs				NT		
Atelerix frontalis angolae	Southern African Hedgehog		Insufficiently Known; Rare?; Protected Game			
Carnivores						
Proteles cristatus	Aardwolf		Insufficiently Known; Vulnerable?; Peripheral; Protected Game			
Parahyaena (Hyaena) brunnea	Brown Hyena		Insufficiently Known; Vulnerable?; Peripheral; Protected Game	NT	NT	
Crocuta crocuta	Spotted Hyena		Secure; Peripheral; Protected Game			
Acinonyx jubatus	Cheetah		Vulnerable; Protected Game	V	V	C1
Panthera pardus	Leopard		Secure; Peripheral; Protected Game		V	C1
Panthera leo	Lion		Indeterminate; Vulnerable?; Peripheral; Protected Game	V	V	C2
Felis caracal	Caracal		Secure; Problem Animal			C2
Felis lybica	African Wild Cat		Vulnerable			C2
Leptailurus serval	Serval	√[1,2]	Indeterminate	NT		C2
Civittictis civetta	African Civet		Indeterminate; Rare?: Peripheral			
Genetta genetta	Small-spotted Genet		Secure			
Otocyon megalotis	Bat-eared Fox		Vulnerable?; Peripheral; Protected Game			
Lycaon pictus	African Wild Dog		Endangered	E	E	
Vulpes chama	Cape Fox		Vulnerable?; Protected Game			
Canis mesomelas	Black-backed Jackal	√	Secure; Problem Animal			
Mellivora capensis	Ratel or Honey Badger		Secure; Protected Game	NT		
Ictonyx striatus	Striped Polecat	√	Secure			

Species: Scientific name	Species: Common name	Species confirmed	Namibian conservation and legal status	International status:		
				SARDB (2004)	IUCN (2021)	CITES
Cynictis penicillata	Yellow Mongoose	√	Secure			
Galerella sanguinea	Slender Mongoose	√	Secure			
Mungos mungo	Banded Mongoose	√*	Secure			
Helogale parvula	Dwarf Mongoose		Secure			
Perissodactyla:						
Zebra						
Equus (burchellii) quagga	Plains Zebra		Insufficiently Known; Endangered?; Peripheral; Specially Protected Game			
Artiodactyla:						
Pigs						
Phacochoerus aethiopicus	Common Warthog	√*	Secure; Huntable Game			
Ruminants						
Giraffa camelopardalis angolensis	Giraffe		Vulnerable?; Peripheral; Specially Protected Game			
Connochaetes taurinus	Blue Wildebeest		Insufficiently Known; Vulnerable?; Protected Game			
Tragelaphus strepsiceros	Greater Kudu	√	Secure; Huntable Game			
Oryx gazella	Gemsbok	√*	Secure; Huntable Game			
Sylvicapra grimmia	Common Duiker	√*	Secure; Protected Game			
Antidorcas marsupialis	Springbok	√	Secure; Huntable Game			
Aepyceros melampus petersi	Black-faced Impala	√	Endemic; Indeterminate; Vulnerable?; Peripheral; Specially Protected Game		V	
Tragelaphus oryx	Eland		Insufficiently Known; Vulnerable?; Protected Game			
Madoqua damarensis	Damara Dik-Dik	√*	Insufficiently Known; Protected Game			
Raphicerus campestris	Steenbok	√*	Secure; Protected Game			

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 (2021): E – Endangered; V- Vulnerable; NT – Near Threatened. All other species listed as Least Concern (LC) and/or have not yet been assessed for the IUCN Red List.
CITES – Convention on International Trade in Endangered Species of Wild Fauna and Flora. C1 and 2 = CITES Appendix 1 and 2 species.
#Monadjem *et al.* (2010): V- Vulnerable; NT – Near Threatened; DD – Data Deficient
√* – Authors personal records from general area
√[1,2] – Stratford *et al.* (2016), Edwards *et al.* (2017)

Source for literature review: De Graaff (1981), Edwards *et al.* (2017), Estes (1995), Griffin (1998c), Griffin and Coetzee (2005), IUCN (2021), Joubert and Mostert (1975), Monadjem *et al.* (2010), Picker and Griffiths (2011), SARDB (2004), Skinner and Smithers (1990), Skinner and Chimimba (2005), Stander and Hansson (2003), Stratford *et al.* (2016) and Taylor (2000).

At least 27.8% and 21.5% of the mammalian fauna that occur and/or are expected to occur in the general area are represented by bats (27 species) and carnivores (21 species) and rats and mice (21 species), respectively. 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 8 species were confirmed along the various seismic survey routes assessed and 19 species from the general area using the author's previous records. This included Damaraland mole-rat, black-backed jackal, striped polecat, yellow mongoose, slender mongoose, kudu, springbok and black-faced impala – i.e. a total of at least 8 species are confirmed from the general area – See Table 3. However, species such as elephant, lion, wild dog, etc. are only expected to move through the general area and not permanently associated with the area.

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. 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 (Figures 6-7).

Figure 6. Land cleared for small scale agriculture in the AOI02 area, affects the overall presence and abundance of mammals throughout the general area.

Figure 7. Land clearing activities in the AOI01 area 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 (*Kerivoula lanosa*, *Zelotomys woosnami*, *Atelerix frontalis angolae*, *Civittictis civetta*), endangered (*Lycaon pictus*, *Equus (burchellii) quagga*) and vulnerable, under Namibian legislation and those classified by the IUCN (2021) as endangered (*Loxodonta africana*, *Lycaon pictus*), vulnerable (*Smutsia (Manis) temminckii*, *Acinonyx jubatus*, *Panthera pardus*, *Panthera leo*, *Aepyceros melampus petersi*) and near threatened (*Macronycteris (Hipposideros) vittatus*, *Parahyaena (Hyaena) brunnea*). However, some of the above species – e.g. elephant, wild dog, etc. – only pass through the area – or are associated with game farms – zebra, black-faced impala – (i.e. introduced onto farms in the AOI00). 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 close to towns, villages and settlements such as Oshivelo, etc.; crop production and land clearing on freehold farms; subsistence farming activities in communal areas, etc. and none of the unique mammals are expected to be exclusively associated with the seismic survey routes in AOI00, AOI01 and AOI02. The proposed mitigations – See Section 4 – are expected to minimise the overall effect on amphibians potentially occurring in the area.

Impact of seismic activity and seismic lines along existing roads/tracks:
A typical weight drop would have a peak force output of 860,000lbs (~430,000kg) at base plate 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.

A single vibrator truck can generate more than 178 N (Newton of ground force), and usually four trucks are clustered together to create the energy at each source point, creating a combined ground force of 667 to 890 kN (kilonewton of ground force). A seismic vibrator transforms the energy provided by a diesel engine into a vibration. It is performed by a shaker, a movable element that generates the vibration, thanks to a piston-reaction mass device driven by an electro hydraulic servo valve. The shaker is applied to the ground for

each vibration and then raised up so that the seismic vibrator can move to another vibrating point. Vibroseis do not cause any disturbance except for the need to widen the track and for a light terrain vibration to be felt and read by the geophones – i.e. no explosives are required. 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 vibroseis 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, 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 west, in the Etosha National Park, with occasional movements to the east, between the park and the Mangetti Block area as well as some freehold farms in the Tsintsabis area. The seismic surveys will be executed to the north and east 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 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, the extension of seismic line 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).

Impact of new seismic lines:
Habitat destruction would occur along new routes envisaged. The widening and upgrading of the existing sandy tracks is also expected to contribute to habitat destruction/alteration. Increased traffic along these new access routes 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 93 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 dry savannah in central Namibia (Brown *et al.* 1998).

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.

Species: Scientific name	Species: Common name	Species confirmed	Namibian conservation and legal status	International status	
				Southern Africa	IUCN (2021)
Struthio camelus	Common Ostrich				
Dendroperdix sephaena	Crested Francolin	√			
Scleroptila levailantoides	Orange River Francolin			N-End	
Pternistis hartlaubi	Hartlaub's Spurfowl		End	N-End	
Francolinus adspersus	Red-billed Spurfowl	√		N-End	
Pternistis swainsonii	Swainson's Spurfowl				
Coturnix coturnix	Common Quail				
Coturnix delegorguei	Harlequin Quail				
Numida meleagris	Helmeted Guineafowl	√			
Trunix sylvatica	Kurrichane Buttonquail				
Indicator minor	Lesser Honeyguide				
Campethera bennettii	Bennett's Woodpecker				
Campethera abingoni	Golden-tailed Woodpecker				
Dendropicos fuscescens	Cardinal Woodpecker				
Thrioias namaquus	Bearded Woodpecker				
Pogoniulus chrysoconus	Yellow-fronted Tinkerbird				
Lybius leucomelas	Acacia Pied Barbet			N-End	
Tockus monteiri	Monteiro's Hornbill		End		
Tockus erythrorhynchus	Red-billed Hornbill	√			
Tockus damarensis	Damara Hornbill		End	N-End	
Tockus nasutus	African Grey Hornbill	√			
Tockus flavirostris	Southern Yellow-billed Hornbill	√		N-End	
Bucorvus leadbeateri	Southern Ground-Hornbill	√*	E		V
Upupa africana	African Hoopoe	√*			
Phoeniculus purpureus	Green Wood-Hoopoe				
Phoeniculus damarensis	Violet Wood-Hoopoe		E; N-End		
Phoeniculus cyanomelas	Common Scimitarbill				

Species: Scientific name	Species: Common name	Species confirmed	Namibian conservation and legal status	International status	
				Southern Africa	IUCN (2021)
Coracias caudate	Lilac-breasted Roller	√			
Coracias naevia	Purple Roller	√			
Halcyon leucocephala	Grey-headed Kingfisher				
Halcyon senegalensis	Woodland Kingfisher				
Merops pusillus	Little Bee-eater				
Merops hirundineus	Swallow-tailed Bee-eater	√			
Merops apiaster	European Bee-eater				
Colius colius	White-backed Mousebird	√*			
Colius indicus	Red-faced Mousebird	√			
Clamator jacobinus	Jacobin Cuckoo				
Clamator levaillantii	Levaillant's Cuckoo				
Clamator landarius	Great Spotted Cuckoo				
Cuculus gularis	African Cuckoo				
Chrysococcyx klaas	Klaas's Cuckoo				
Chrysococcyx caprius	Diderick Cuckoo	√*			
Poicephalus meyeri	Meyer's Parrot	√			
Poicephalus rueppelii	Rüppell's Parrot		NT; N-End		
Agapornis roseicollis	Rosy-faced Lovebird		End	N-End	
Cypsiurus parvus	African Palm-Swift	√			
Tachymarptis melba	Alpine Swift				
Apus bradfieldi	Bradfield's Swift			N-End	
Apus affinis	Little Swift	√			
Apus caffer	White-rumped Swift				
Corythaixoides concolor	Grey Go-away-bird	√			
Tyto alba	Barn Owl				
Otus senegalensis	African Scops-Owl				
Otus leucotis	Southern White-faced Scops-Owl				
Bubo africanus	Spotted Eagle-Owl				
Bubo lacteus	Verreaux's Eagle-Owl				
Glaucidium perlatum	Pearl-spotted Owlet				
Asio capensis	Marsh Owl				
Caprimulgus pectoralis	Fiery-necked Nightjar				
Caprimulgus tristigma	Freckled Nightjar				

Species: Scientific name	Species: Common name	Species confirmed	Namibian conservation and legal status	International status	
				Southern Africa	IUCN (2021)
Caprimulgus fossii	Square-tailed Nightjar				
Caprimulgus rufigenta	Rufous-cheeked Nightjar				
Columba livia	Rock Dove				
Columba guinea	Speckled Pigeon				
Streptopelia senegalensis	Laughing Dove	√			
Streptopelia decipiens	African Mourning Dove				
Streptopelia capicola	Cape Turtle Dove	√			
Turtur chalcospilos	Emerald-spotted Wood Dove	√			
Oena capensis	Namaqua Dove	√			
Treron calvus	African Green-Pigeon				
Neotis ludwigii	Ludwig's Bustard	√*	E	N-End	E
Ardeotis kori	Kori Bustard	√*	NT		NT
Eupodotis rufisrista	Red-crested Korhaan	√*		N-End	
Afrotis afraoides	Northern Black Korhaan	√*		End	
Balearica regulorum	Grey Crowned Crane		CE		E
Anthropoides paradiseus	Blue Crane		CE	End	V
Bugeranus carunculatus	Wattled Crane		E		V
Pterocles namaqua	Namaqua Sandgrouse	√*		N-End	
Pterocles gutturalis	Yellow-throated Sandgrouse				
Pterocles bicinctus	Double-banded Sandgrouse	√*		N-End	
Pterocles bicinctus	Burchell's Sandgrouse			N-End	
Burhinus vermiculatus	Water Thick-knee				
Burhinus capensis	Spotted Thick-knee	√*			
Vanellus coronatus	Crowned Lapwing				
Vanellus armatus	Blacksmith Lapwing				
Rhinoptilus africanus	Double-banded Courser				
Rhinoptilus chalcopterus	Bronze-winged Courser				
Cursorius rufus	Burchell's Courser			N-End	
Cursorius temminckii	Temminck's Courser				
Macheiramphus alcinus	Bat Hawk				
Elanus caeruleus	Black-shouldered Kite	√*			
Milvus migrans	Black Kite	√			
Necrosyrtes monachus	Hooded Vulture	√*	E		CE

Species: Scientific name	Species: Common name	Species confirmed	Namibian conservation and legal status	International status	
				Southern Africa	IUCN (2021)
Gyps africanus	White-backed Vulture	√*	E		CE
Torgos tracheliotus	Lappet-faced Vulture	√*	V		E
Aegypius occipitalis	White-headed Vulture	√*	V		CE
Circaetus gallicus	Black-chested Snake Eagle	√			
Circaetus cinereus	Brown Snake Eagle	√			
Terathopius ecaudatus	Bateleur	√	E		E
Polyboroides typus	African Harrier-Hawk				
Kaupifalco monogrammicus	Lizard Buzzard				
Melierax canorus	Southern Pale Chanting Goshawk	√			
Micronisus gabar	Gabar Goshawk				
Accipter badius	Shikra	√			
Accipiter minullus	Little Sparrowhawk	√			
Accipiter ovampensis	Ovambo Sparrowhawk				
Buteo augur	Augur Buzzard				
Aquila rapax	Tawny Eagle	√*	E		V
Aquilaverreauxii	Verreauxs' Eagle		NT		
Hieraaetus fasciatus	African Hawk-Eagle				
Aquila pennatus	Booted Eagle		E		
Aquila wahlbergi	Wahlberg's Eagle				
Polemaetus bellicosus	Martial Eagle	√*	E		E
Sagittarius serpentarius	Secretarybird	√*	V		E
Polihierax semitorquatus	Pygmy Falcon	√*			
Falco rupicolis	Rock Kestrel	√*			
Falco rupicoloides	Greater Kestrel	√*			
Falco chicquera	Red-necked Falcon				
Falco cuvierii	African Hobby	√*			
Falco biarmicus	Lanner Falcon	√*			
Falco peregrinus	Peregrine Falcon		NT		
Bubulcus ibis	Cattle Egret	√*			
Leptoptilos crumeniferus	Marabou Stork	√*	NT		
Oriolus auratus	African Golden Oriole	√			
Dicrurus adsimilis	Fork-tailed Drongo	√			
Terpsiphone viridis	African Paradise-Flycatcher	√*			

Species: Scientific name	Species: Common name	Species confirmed	Namibian conservation and legal status	International status	
				Southern Africa	IUCN (2021)
Nilaus afer	Brubru	√*			
Dryoscopus cubla	Black-backed Puffback				
Tchagra australis	Brown-crowned Tchagra				
Tcharga senegalus	Black-crowned Tchagra				
Laniarius atrococcineus	Crimson-breasted Shrike	√		N-End	
Prionops plumatus	White-crested Helmet-Shrike				
Prionops retzii	Retz's Helmet-Shrike				
Lanioturdus torquatus	White-tailed Shrike		End	N-End	
Batis molitor	Chinspot Batis				
Batis pririt	Pririt Batis	√*		N-End	
Corvus capensis	Cape Crow	√*			
Corvus albus	Pied Crow	√*			
Lanius collaris	Common Fiscal	√			
Corvinella melanoleuca	Magpie Shrike				
Eurocephalus anguitimens	Southern White-crowned Shrike			N-End	
Anthoscopus minutes	Cape Penduline-Tit	√		N-End	
Anthoscopus caroli	Grey Penduline-Tit				
Parus carpi	Carp'sTit		End	N-End	
Parus cinerascens	Ashy Tit	√*		N-End	
Riparia paludicola	Brown-throated Martin				
Riparia cincta	Banded Martin				
Hirundo albigularis	White-throated Swallow				
Hirundo cucullata	Greater Striped Swallow				
Hirundo abyssinica	Lesser Striped Swallow				
Hirundo semirufa	Red-breasted Swallow				
Hirundo spilodera	South African Cliff-Swallow	√*			
Hirundo fuligula	Rock Martin				
Pycnonotus nigricans	African Red-eyed Bulbul	√		N-End	
Sylvietta rufescens	Long-billed Crombec				
Eremomela icteropygialis	Yellow-bellied Eremomela				
Eremomela usticollis	Burnt-necked Eremomela				
Acrocephalus baeticatus	African Reed-Warbler				
Turdoides melanops	Black-faced Babbler			N-End	

Species: Scientific name	Species: Common name	Species confirmed	Namibian conservation and legal status	International status	
				Southern Africa	IUCN (2021)
Turdoides bicolor	Southern Pied Babbler			End	
Turdoides gymnogenys	Bare-cheeked Babbler	√*	End		
Parisoma subcaeruleum	Chestnut-vented Tit-Babbler	√*		N-End	
Zosterops pallidus	Orange River White-eye			End	
Cisticola chiniana	Rattling Cisticola				
Cisticola rufilatus	Tinkling Cisticola				
Cisticola fulvicapilla	Neddicky				
Cisticola juncidis	Zitting Cisticola				
Cisticola aridula	Desert Cisticola				
Prinia flavicans	Black-chested Prinia	√			
Malcorus pectoralis	Rufous-eared Warbler				
Apalis flavida	Yellow-breasted Apalis				
Camaroptera brevicaudata	Grey-backed Camaroptera				
Camaroptera fasciolata	Barred Wren-Warbler			N-End	
Mirafra passerine	Monotonous Lark			N-End	
Mirafra africana	Rufous-naped Lark				
Mirafra apiata	Eastern Clapper Lark			N-End	
Mirafra sabota	Sabota Lark				
Mirafra africanoides	Fawn-coloured Lark			N-End	
Pinarocorys nigricans	Dusky Lark				
Chersomanes albofasciata	Spike-healed Lark			N-End	
Eremopterix leucotis	Chestnut-backed Sparrowlark	√*			
Eremopterix verticalis	Grey-backed Sparrowlark			N-End	
Calandrella cinerea	Red-capped Lark				
Spizocorys starki	Stark's Lark			End	
Spizocorys conirostris	Pink-billed Lark				
Monticola brevipes	Short-toed Rock-Thrush			N-End	
Turdus litsitsirupa	Groundscraper Thrush	√*			
Turdus libonyana	Kurrichane Thrush				
Melaenornis infuscatus	Chat Flycatcher			N-End	
Melaenornis mariquensis	Marico Flycatcher	√*		N-End	
Muscicapa striata	Spotted Flycatcher				
Cercotrichas leucophrys	White-browed Scrub-Robin	√*			

Species: Scientific name	Species: Common name	Species confirmed	Namibian conservation and legal status	International status	
				Southern Africa	IUCN (2021)
Erythropygia paena	Kalahari Scrub-Robin	√*		N-End	
Oenanthe pileata	Capped Wheatear				
Cercomela familiaris	Familiar Chat	√*			
Myrmecocichla formicivora	Ant-eating Chat	√*		End	
Onychognathus nabouroup	Pale-winged Starling	√		N-End	
Lamprotornis nitens	Cape Glossy Starling	√			
Lamprotornis chalybaeus	Greater Blue-eared Starling				
Lamprotornis australis	Burchell's Starling	√		N-End	
Cinnyricinclus leucogaster	Violet-backed Starling				
Creatophora cinerea	Wattled Starling	√*			
Buphagus africanus	Yellow-billed Oxpecker		E		
Chalcomitra amethystina	Amethyst Sunbird	√			
Nectarinia senegalensis	Scarlet-chested Sunbird				
Cinnyris talatala	White-bellied Sunbird				
Cinnyris fuscus	Dusky Sunbird	√*		N-End	
Nectarinia mariquensis	Marico Sunbird				
Bubalornis niger	Red-billed Buffalo-Weaver	√			
Sporopipes squamifrons	Scaly-feathered Finch	√		N-End	
Plocepasser mahali	White-browed Sparrow-weaver	√			
Philetairus socius	Sociable Weaver	√*		End	
Ploceus intermedius	Lesser Masked Weaver	√*			
Ploceus velatus	Southern Masked Weaver	√			
Ploceus rubiginosus	Chestnut Weaver	√*			
Anaplectes melanotis	Red-headed Weaver	√			
Quelea quelea	Red-billed Quelea	√			
Euplectes afer	Yellow-crowned Bishop				
Euplectes orix	Southern Red Bishop				
Ortygospiza atricollis	African Quailfinch				
Amadina erythrocephala	Red-headed Finch	√*		N-End	
Amadina fasciata	Cut-throat Finch				
Uraeginthus granatinus	Violet-eared Waxbill	√*			
Estrilda astrild	Common Waxbill				
Estrilda erythronotos	Black-faced Waxbill	√*			

Species: Scientific name	Species: Common name	Species confirmed	Namibian conservation and legal status	International status	
				Southern Africa	IUCN (2021)
Uraeginthus angolensis	Blue Waxbill	√*			
Pytilia melba	Green-winged Pytilia	√*			
Vidua macroura	Pin-tailed Whydah	√			
Vidua paradisaea	Long-tailed Paradise Whydah				
Vidua regia	Shaft-tailed Whydah	√		N-End	
Passer domesticus	House Sparrow				
Passer motitensis	Great Sparrow			N-End	
Passer melanurus	Cape Sparrow	√*		N-End	
Passer griseus	Southern Grey-headed Sparrow				
Petronia superciliaris	Yellow-throated Petronia				
Motocilla aguimp	African Pied Wagtail				
Motacilla capensis	Cape Wagtail				
Anthus cinnamomeus	African Pipit			End	
Anthus leucophrys	Plain-backed Pipit				
Anthus valensis	Buffy Pipit				
Anthus similis	Long-billed Pipit				
Crithagra mozambica	Yellow-fronted Canary				
Serinus atrogularis	Black-throated Canary	√*			
Serinus flaviventris	Yellow Canary	√*		N-End	
Crithagra albogularis	White-throated Canary	√*		N-End	
Emberiza impetuani	Lark-like Bunting	√*		N-End	
Emberiza tahapisi	Cinnamon-breasted Bunting				
Ebberiza capensis	Cape Bunting			N-End	
Emberiza flaviventris	Golden-breasted Bunting	√*			

Namibian (Simmons *et al.* 2015): CE – Critically Endangered; E – Endangered; V – Vulnerable; NT – Near Threatened
Southern African (Hockey et al. 2006): End – Endemic; N-end – Near Endemic
IUCN (2021): CE – Critically Endangered; E – Endangered; V – Vulnerable; NT – Near Threatened; All other birds either listed as least concern or not yet been assessed for the IUCN Red List
√* – Authors personal records from general area

Source for literature review: Brown *et al.* (1998), Hockey *et al.* (2006), IUCN (2021), Komen (n.d.), Little *et al.* (2011), Maclean (1985), Peacock (2015), Simmons *et al.* (2015) and Tarboton (2001)

Bird diversity is viewed as "average" in the general area with between 171-230 species estimated of which 1-3 species are viewed as endemic (Mendelsohn *et al.* 2000). Simmons (1998a) indicates 1-6 endemic species in the area and "average" rankings for southern African endemics and red data birds. Furthermore, although the PEL 93 area is not classified as an Important Birding Area (IBA) in Namibia, Etosha, to the immediate west of the area, have Global IBA status including Ramsar status for the Etosha Pan area (Simmons 1998b).

At least 250 species of terrestrial ["breeding residents"] birds occur and/or could occur in the general area at any time (Hockey *et al.* 2006, Maclean 1985, Tarboton 2001). All the aquatic, extralimital breeders and migrant species have been excluded here. Seven of the 14 Namibian endemics are expected to occur in the general area. Two species are classified as critically endangered (grey crowned crane, blue crane), 10 species are classified as endangered (southern ground-hornbill, Lüdwig's bustard, wattled crane, hooded vulture, white-backed vulture, bateleur, tawny eagle, booted eagle, martial eagle, yellow-billed oxpecker), 3 species as vulnerable (lappet-faced vulture, white-headed vulture, secretarybird) and 5 species as near threatened (Rüppell's parrot, kori bustard, Verreauxs' eagle, peregrine falcon, marabou stork) from Namibia (Simmons *et al.* 2015). The IUCN (2021) classifies 3 species as critically endangered (hooded vulture, white-headed vulture, white-backed vulture), 6 species as endangered (Ludwig's bustard, grey crowned crane, lappet-faced vulture, bateleur, martial eagle, secretarybird), 4 species as vulnerable (southern ground-hornbill, blue crane, wattled crane, tawny eagle) and 1 species as near threatened (kori bustard).

Some of the important bird species are only known to be associated with specific habitats – e.g. especially ephemeral pans – in the Etosha and Omudhiya Lakes areas – e.g. grey crowned crane, blue crane, wattled crane, etc. – and not expected to occur in the AOI, although may occasionally pass through the areas.

Fifty four species (21.6% of all the birds expected) have a southern African conservation rating with 8 species classified as endemic (14.8% of southern African endemics or 3.2% of all the birds expected) and 46 species classified as near endemic (85.2% of southern African endemics or 18.4% 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 Owambo or whilst moving between wetlands in Etosha and the Omudhiya Lakes (north of Etosha Pan) 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 45 species were confirmed along the various roads/tracks in the general AOI assessed of which 1 species is not included in Table 4 as it is a migratory species (i.e. steppe buzzard) and another 58 species from the general area using the author's previous records (Table 4).

However, many other aquatic species would be associated with the Etosha Pan and other pan systems throughout the area when water collects, but not included here. The Omuramba Owambo may attract aquatic species in inland areas when water collects after rain showers.

The most important species are viewed as the 7 endemics and those classified as critically endangered (grey crowned crane, blue crane), endangered (southern ground-hornbill, Lüdwig's bustard, wattled crane, hooded vulture, white-backed vulture, bateleur, tawny

eagle, booted eagle, martial eagle, yellow-billed oxpecker), vulnerable (lappet-faced vulture, white-headed vulture, secretarybird) and near threatened (Rüppell's Parrot, kori bustard, Verreauxs' Eagle, peregrine falcon, marabou stork) from Namibia (Simmons *et al.* 2015) and those classified by the IUCN (2021) as critically endangered (hooded vulture, white-headed vulture, white-backed vulture), endangered (Ludwig's bustard, grey crowned crane, lappet-faced vulture, bateleur, martial eagle, secretarybird), vulnerable (southern ground-hornbill, blue crane, wattled crane, tawny eagle) and near threatened (kori bustard). An important species confirmed from the general area is the yellow-billed oxpecker. Although oxpecker numbers have increased in communal areas in northern 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 close to towns, villages and settlements such as Oshivelo, etc.; crop production and land clearing on freehold farms; subsistence farming activities in communal areas, etc. and none of the unique birds are expected to be exclusively associated with the seismic survey routes in AOI00, AOI01 and AOI02. The proposed mitigations – See Section 4 – are expected to minimise the overall effect on amphibians potentially occurring in the area.

Impact of seismic activity and seismic lines along existing roads/tracks:
A typical weight drop would have a peak force output of 860,000lbs (~430,000kg) at base plate 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.

A single vibrator truck can generate more than 178 N (Newton of ground force), and usually four trucks are clustered together to create the energy at each source point, creating a combined ground force of 667 to 890 kN (kilonewton of ground force). A seismic vibrator transforms the energy provided by a diesel engine into a vibration. It is performed by a shaker, a movable element that generates the vibration, thanks to a piston-reaction mass device driven by an electro hydraulic servo valve. The shaker is applied to the ground for each vibration and then raised up so that the seismic vibrator can move to another vibrating point. Vibroseis do not cause any disturbance except for the need to widen the track and for a light terrain vibration to be felt and read by the geophones – i.e. no explosives are required. 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 vibroseis technology, will have any lasting negative impacts on birds 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, the extension of seismic line 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).

Impact of new seismic lines:
Habitat destruction would occur along new routes envisaged. The widening and upgrading of the existing sandy tracks are also expected to contribute to habitat destruction/alteration. Habitat destruction, due to the creation and widening of new tracks, especially through the Omuramba's Owambo and Omuthiya (and other ephemeral drainage lines and pans), is more important although the actual footprint is small. Increased traffic along these new access routes 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 93 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 within the various AOI (i.e. general seismic routes) while Table 6 indicates tree and shrub diversity at each of the 46 vegetation survey points conducted within the AOI (30 x AOI00; 8 x AOI01; 8 x AOI02).

At least 95 species of larger trees/shrubs are expected to occur in the general area of which none are viewed as endemics. Eighteen species (18.9%) are protected by the Forest Act No. 12 of 2001 while 1 species is protected by the Nature Conservation Ordinance No. 4 of 1975 (1.1%) (Mannheimer and Curtis 2018). Two species are classified as Lower Risk (Near Threatened) (2.1%) (Loots 2005). Species with the most diversity expected from the general area are *Acacia* (16 species) and *Combretum* (12 species) and followed by *Grewia* (10 species).

During the fieldwork a total of 51 larger trees and shrubs was confirmed from the various AOI with the AOI00 (40spp.), AOI01 (26spp.) and AOI02 (24spp.) declining in species composition from south to north (See Table 5 and Table 6a-f). Of these 51 species, 7 species are protected by the Forest Act No12. of 2001 – i.e. 13.7%. The actual vegetation survey points varied between 7 and 16 species, respectively (See Table 6a-g).

The most important larger tree and shrub species expected to occur in the general area include all those formally protected (See Tables 5 and 6a-g) with the most important species viewed as *Baikiaea plurijuga*, *Burkea africana* and *Sclerocarya birrea.* Another important species, classified as Lower Risk/Near Threatened by the IUCN (2021), is *Pterocarpus angolensis* (African teak or Kiaat) (De Cauwer *et al.* 2014) while *Baikiaea plurijuga* (Zambezi/Rhodesian Teak) is viewed as the most important in the general area due to numbers having decreased due to overutilization for wood production; elephant damage and unseasonal human induced fires (Figures 8-14).

Figure 8. *Albizia anthelmintica* (worm cure Albizia) – protected – are important medicinal and fodder trees in the general area (AOI01).

Table 5. Tree and shrub diversity expected (literature study, using Mannheimer and Curtis 2018) and confirmed (fieldwork) along various tracks in the general AOI (i.e. general seismic survey routes) (See Figure 1). Species indicated are known from the quarter-degree square distribution principle used and don't necessarily occur throughout the entire area.

Species: Scientific name	Species confirmed			Namibian conservation and legal status	International status (IUCN 2020)
	AOI00	AOI01	AOI02		
Acacia arenaria	√				
Acacia ataxacantha		√	√Δ		
Acacia erioloba	√	√Δ	√	Protected (F#)	LC
Acacia erubescens	√				
Acacia fleckii		√	√		
Acacia hebeclada	√				
Acacia karroo	√				
Acacia kirkii					
Acacia luederitzii					
Acacia mellifera	√Δ	√Δ			
Acacia nebrownii			√		
Acacia nilotica	√				
Acacia reficiens	√Δ	√	√		
Acacia senegal			√		
Acacia sieberiana					
Acacia tortilis	√				LC
Adenium boehmianum				Protected (F#)	
Albizia anthelmintica	√	√	√	Protected (F#)	LC
Aloe litoralis				NC; C2	
Baikiaea plurijuga			√Δ	Protected (F#); LR-nt	NT
Baphia massaiensis		√Δ	√Δ		
Bauhinia petersiana		√	√		
Boscia albitrunca	√	√	√	Protected (F#); LR-nt	LC
Boscia foetida					
Burkea africana		√	√	Protected (F#)	LC
Catophractes alexandri	√	√			
Colophospermum mopane				Protected (F#)	
Combretum apiculatum	√Δ	√			
Combretum celastroides		√			
Combretum collinum	√	√	√Δ		

Species: Scientific name	Species confirmed			Namibian conservation and legal status	International status (IUCN 2020)
	AOI00	AOI01	AOI02		
Combretum hereroense	√Δ	√Δ	√		
Combretum mosambicense					
Combretum imberbe	√			Protected (F#)	LC
Commiphora africana					
Commiphora angolensis					
Commiphora glandulosa	√		√		
Commiphora mollis					
Commiphora pyracanthoides	√				
Commiphora tenuipetiolata					
Cordia sinensis					
Croton gratissimus	√	√	√		
Croton menyharthii					
Dichrostachys cinerea	√Δ	√	√Δ		
Diospyros lycioides			√		
Diospyros mespiliformis				Protected (F#)	
Ehretia alba					
Ehretia namibiensis					
Elaeodendron transvaalense					
Elephantorrhiza suffruticosa					
Euclea divinorum					
Euclea undulata	√				
Ficus burkei/F. petersii				Protected (F#)	
Ficus cordata				Protected (F#)	
Ficus sycomorus		√		Protected (F#)	
Fockea multiflora					
Grewia avellana					
Grewia bicolor	√	√	√		
Grewia flava	√	√	√		
Grewia flavescens					
Grewia olukondae					
Grewia retinervis	√				
Grewia schinzii					
Grewia subspathulata					
Grewia tenax					

Species: Scientific name	Species confirmed			Namibian conservation and legal status	International status (IUCN 2020)
	AOI00	AOI01	AOI02		
Grewia villosa	√				
Gossypium herbaceum					
Gossypium triphyllum					
Gymnosporia senegalensis	√				
Hyphaene petersiana	√			Protected (F#)	
Ipomoea adenioides					
Lycium cinereum					
Maerua schinzii				Protected (F#)	LC
Mundulea sericea	√	√	√		
Ozoroa insignis					
Ozoroa paniculosa	√				
Ozoroa schinzii					
Pavetta zeyheri					
Pechuel-Loeschea leubnitziae	√	√			
Peltophorum africanum	√				
Philenoptera nelsii	√	√	√		LC
Rhigozum brevispinosum					
Salvadora persica					
Searsia ciliata					
Searsia marlothii					
Searsia tenuinervis	√	√			
Schinziophyton rautanenii				Protected (F#)	LC
Sclerocarya birrea	√			Protected (F#)	
Spirostachys africana	√Δ			Protected (F#)	
Terminalia prunioides	√Δ	√	√		
Terminalia sericea	√	√Δ	√Δ		
Vangueria infausta	√				
Veronia cinerascens					
Ximenia americana	√				LC
Ximenia caffra var. *caffra*					
Ziziphus mucronata	√			Protected (F#)	LC
Total number of species:	40	26	24		
Important areas:	O	OO	OO		
Invasive alien species:	-	-	-		

Species: Scientific name	Species confirmed			Namibian conservation and legal status	International status (IUCN 2020)
	AOI00	AOI01	AOI02		
Wildlife tracks:	Yes	-	-		

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
IUCN (2021): NT – Near Threatened; LC – Least Concern. All other species eitherlisted as LC or not yet been assessed for the IUCN Red List
Important areas: ENP = Etosha NP; O = Omuramba Owambo; OO = Omaramba Omuthiya
Invasive alien species: N/A
[The use of *Acacia* is made throughout rather than *Senegalia* and/or *Vachellia*]

Source for literature review: Mannheimer and Curtis (2018)

Table 6a. Tree and shrub diversity expected and confirmed during the fieldwork at each of the 14 vegetation survey points conducted along the D3001 (5km apart) – AOI00.

Species: Scientific name	Species confirmed - D3001														Namibian conservation and legal status	International status (IUCN 2021)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
Acacia arenaria					√	√										
Acacia ataxacantha																
Acacia erioloba	√						√		√	√	√		√	√	Protected (F#)	LC
Acacia erubescens	√													√		
Acacia fleckii																
Acacia hebeclada																
Acacia karroo			√													
Acacia kirkii																
Acacia luederitzii																
Acacia mellifera			√							√			√			
Acacia nebrownii																
Acacia nilotica		√	√	√				√	√		√	√	√	√		
Acacia reficiens		√			√	√			√		√					

Species: Scientific name	Species confirmed - D3001														Namibian conservation and legal status	International status (IUCN 2021)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
Acacia senegal																
Acacia sieberiana																
Acacia tortilis		√	√		√				√			√	√	√		LC
Adenium boehmianum															Protected (F#)	
Albizia anthelmintica			√		√										Protected (F#)	LC
Aloe litoralis															NC; C2	
Baikiaea plurijuga															Protected (F#); LR-nt	NT
Baphia massaiensis																
Bauhinia petersiana																
Boscia albitrunca															Protected (F#); LR-nt	LC
Boscia foetida																
Burkea africana															Protected (F#)	LC
Catophractes alexandri																
Colophospermum mopane															Protected (F#)	
Combretum apiculatum	√	√	√Δ	√	√	√Δ	√		√Δ		√	√	√	√		
Combretum celastroides																
Combretum collinum	√	√	√													
Combretum hereroense	√		√	√	√	√	√				√	√	√	√		
Combretum mosambicense																
Combretum imberbe			√	√	√			√				√			Protected (F#)	LC
Commiphora africana																
Commiphora angolensis																
Commiphora glandulosa																
Commiphora mollis																
Commiphora pyracanthoides										√						
Commiphora tenuipetiolata																
Cordia sinensis																
Croton gratissimus						√										
Croton menyharthii																
Dichrostachys cinerea	√Δ	√Δ	√Δ	√Δ	√Δ	√Δ	√Δ	√Δ		√		√Δ	√	√		
Diospyros lycioides																
Diospyros mespiliformis															Protected (F#)	
Ehretia alba																

Species: Scientific name	Species confirmed - D3001														Namibian conservation and legal status	International status (IUCN 2021)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
Ehretia namibiensis																
Elaeodendron transvaalense																
Elephantorrhiza suffruticosa																
Euclea divinorum																
Euclea undulata													√			
Ficus burkei/F. petersii															Protected (F#)	
Ficus cordata															Protected (F#)	
Ficus sycomorus															Protected (F#)	
Fockea multiflora																
Grewia avellana																
Grewia bicolor	√										√		√			
Grewia flava																
Grewia flavescens																
Grewia olukondae																
Grewia retinervis	√															
Grewia schinzii																
Grewia subspathulata																
Grewia tenax																
Grewia villosa																
Gossypium herbaceum																
Gossypium triphyllum																
Gymnosporia senegalensis														√		
Hyphaene petersiana						√	√	√	√	√	√		√	√	Protected (F#)	
Ipomoea adenioides																
Lycium cinereum																
Maerua schinzii															Protected (F#)	LC
Mundulea sericea																
Ozoroa insignis																
Ozoroa paniculosa				√		√	√	√	√	√	√	√	√			
Ozoroa schinzii																
Pavetta zeyheri																
Pechuel-Loeschea leubnitziae																
Peltophorum africanum						√							√	√		

Species: Scientific name	Species confirmed - D3001														Namibian conservation and legal status	International status (IUCN 2021)
	1	2	3	4	5	6	7	8	9	10	11	12	13	14		
Philenoptera nelsii		√										√				LC
Rhigozum brevispinosum																
Salvadora persica																
Searsia ciliata																
Searsia marlothii																
Searsia tenuinervis																
Schinziophyton rautanenii															Protected (F#)	LC
Sclerocarya birrea							√	√			√				Protected (F#)	
Spirostachys africana		√	√		√	√	√	√	√Δ	√	√	√	√		Protected (F#)	
Terminalia prunioides		√Δ		√Δ	√Δ	√	√Δ	√Δ	√	√Δ	√Δ	√Δ	√Δ	√Δ		
Terminalia sericea	√															
Vangueria infausta																
Veronia cinerascens																
Ximenia americana		√					√				√					LC
Ximenia caffra var. *caffra*																
Ziziphus mucronata		√	√										√		Protected (F#)	LC
Total number of species:	9	11	12	8	10	11	10	8	9	8	12	10	16	11		
Important areas:	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Invasive alien species:	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Wildlife tracks:	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		

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
IUCN (2021): NT – Near Threatened; LC – Least Concern. All other species eitherlisted as LC or not yet been assessed for the IUCN Red List
Important areas: ENP = Etosha NP; O = Omuramba Owambo; OO = Omaramba Omuthiya
Invasive alien species: N/A
[The use of *Acacia* is made throughout rather than *Senegalia* and/or *Vachellia*]

Table 6b. Tree and shrub diversity expected and confirmed during the fieldwork at each of the 4 vegetation survey points conducted along the D3004 (5km apart) – AOI00.

Species: Scientific name	Species confirmed - D3004				Namibian conservation and legal status	International status (IUCN 2021)
	1	2	3	4		
Acacia arenaria						
Acacia ataxacantha						
Acacia erioloba	√				Protected (F#)	LC
Acacia erubescens						
Acacia fleckii						
Acacia hebeclada						
Acacia karroo						
Acacia kirkii						
Acacia luederitzii						
Acacia mellifera	√	√	√	√		
Acacia nebrownii						
Acacia nilotica	√	√	√	√		
Acacia reficiens	√		√	√		
Acacia senegal						
Acacia sieberiana						
Acacia tortilis		√	√			LC
Adenium boehmianum					Protected (F#)	
Albizia anthelmintica	√			√	Protected (F#)	LC
Aloe litoralis					NC; C2	
Baikiaea plurijuga					Protected (F#); LR-nt	NT
Baphia massaiensis						
Bauhinia petersiana						
Boscia albitrunca					Protected (F#); LR-nt	LC
Boscia foetida						
Burkea africana					Protected (F#)	LC
Catophractes alexandri						
Colophospermum mopane					Protected (F#)	
Combretum apiculatum	√					
Combretum celastroides						
Combretum collinum						
Combretum hereroense	√	√				
Combretum mosambicense						

Species: Scientific name	Species confirmed - D3004				Namibian conservation and legal status	International status (IUCN 2021)
	1	2	3	4		
Combretum imberbe	√		√		Protected (F#)	LC
Commiphora africana						
Commiphora angolensis						
Commiphora glandulosa						
Commiphora mollis						
Commiphora pyracanthoides						
Commiphora tenuipetiolata						
Cordia sinensis						
Croton gratissimus		√		√		
Croton menyharthii						
Dichrostachys cinerea	√Δ	√Δ		√		
Diospyros lycioides						
Diospyros mespiliformis					Protected (F#)	
Ehretia alba						
Ehretia namibiensis						
Elaeodendron transvaalense						
Elephantorrhiza suffruticosa						
Euclea divinorum						
Euclea undulata						
Ficus burkei/F. petersii					Protected (F#)	
Ficus cordata					Protected (F#)	
Ficus sycomorus					Protected (F#)	
Fockea multiflora						
Grewia avellana						
Grewia bicolor				√		
Grewia flava				√		
Grewia flavescens						
Grewia olukondae						
Grewia retinervis						
Grewia schinzii						
Grewia subspathulata						
Grewia tenax						
Grewia villosa						
Gossypium herbaceum						
Gossypium triphyllum						

Species: Scientific name	Species confirmed - D3004				Namibian conservation and legal status	International status (IUCN 2021)
	1	2	3	4		
Gymnosporia senegalensis			√			
Hyphaene petersiana					Protected (F#)	
Ipomoea adenioides						
Lycium cinereum						
Maerua schinzii					Protected (F#)	LC
Mundulea sericea			√			
Ozoroa insignis						
Ozoroa paniculosa	√	√	√	√		
Ozoroa schinzii						
Pavetta zeyheri						
Pechuel-Loeschea leubnitziae						
Peltophorum africanum						
Philenoptera nelsii		√	√	√		LC
Rhigozum brevispinosum						
Salvadora persica						
Searsia ciliata						
Searsia marlothii						
Searsia tenuinervis						
Schinziophyton rautanenii					Protected (F#)	LC
Sclerocarya birrea					Protected (F#)	
Spirostachys africana	√	√Δ	√	√Δ	Protected (F#)	
Terminalia prunioides	√	√	√Δ			
Terminalia sericea						
Vangueria infausta				√		
Veronia cinerascens						
Ximenia americana				√		LC
Ximenia caffra var. *caffra*						
Ziziphus mucronata			√		Protected (F#)	LC
Total number of species:	12	10	12	14		
Important areas:	-	-	-	-		
Invasive alien species:	-	-	-	-		
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)
√**Δ** – Dominant species
IUCN (2021): NT – Near Threatened; LC – Least Concern. All other species eitherlisted as LC or not yet been assessed for the IUCN Red List
Important areas: ENP = Etosha NP; O = Omuramba Owambo; OO = Omaramba Omuthiya
Invasive alien species: N/A
[The use of *Acacia* is made throughout rather than *Senegalia* and/or *Vachellia*]

Table 6c. Tree and shrub diversity expected and confirmed during the fieldwork at each of the 4 vegetation survey points conducted along the D3007 (5km apart) – AOI00.

Species: Scientific name	Species confirmed - D3007				Namibian conservation and	International status (IUCN 2021)
	1	2	3	4	legal status	
Acacia arenaria						
Acacia ataxacantha						
Acacia erioloba		√			Protected (F#)	LC
Acacia erubescens				√		
Acacia fleckii						
Acacia hebeclada						
Acacia karroo						
Acacia kirkii						
Acacia luederitzii						
Acacia mellifera		√Δ	√			
Acacia nebrownii						
Acacia nilotica						
Acacia reficiens	√	√Δ		√		
Acacia senegal						
Acacia sieberiana				√		
Acacia tortilis						LC
Adenium boehmianum					Protected (F#)	
Albizia anthelmintica	√	√			Protected (F#)	LC
Aloe litoralis					NC; C2	
Baikiaea plurijuga					Protected (F#); LR-nt	NT
Baphia massaiensis						
Bauhinia petersiana						
Boscia albitrunca					Protected (F#); LR-nt	LC
Boscia foetida						

Species: Scientific name	Species confirmed - D3007				Namibian conservation and legal status	International status (IUCN 2021)
	1	2	3	4		
Burkea africana					Protected (F#)	LC
Catophractes alexandri						
Colophospermum mopane					Protected (F#)	
Combretum apiculatum	√	√	√			
Combretum celastroides						
Combretum collinum						
Combretum hereroense		√		√		
Combretum mosambicense						
Combretum imberbe	√			√	Protected (F#)	LC
Commiphora africana						
Commiphora angolensis						
Commiphora glandulosa		√				
Commiphora mollis						
Commiphora pyracanthoides						
Commiphora tenuipetiolata						
Cordia sinensis						
Croton gratissimus	√	√				
Croton menyharthii						
Dichrostachys cinerea	√Δ	√	√	√Δ		
Diospyros lycioides						
Diospyros mespiliformis					Protected (F#)	
Ehretia alba						
Ehretia namibiensis						
Elaeodendron transvaalense						
Elephantorrhiza suffruticosa						
Euclea divinorum						
Euclea undulata			√			
Ficus burkei/F. petersii					Protected (F#)	
Ficus cordata					Protected (F#)	
Ficus sycomorus					Protected (F#)	
Fockea multiflora						
Grewia avellana						
Grewia bicolor			√			
Grewia flava						
Grewia flavescens						

Species: Scientific name	Species confirmed - D3007				Namibian conservation and legal status	International status (IUCN 2021)
	1	2	3	4		
Grewia olukondae						
Grewia retinervis						
Grewia schinzii						
Grewia subspathulata						
Grewia tenax						
Grewia villosa						
Gossypium herbaceum						
Gossypium triphyllum						
Gymnosporia senegalensis						
Hyphaene petersiana					Protected (F#)	
Ipomoea adenioides						
Lycium cinereum						
Maerua schinzii					Protected (F#)	LC
Mundulea sericea		√				
Ozoroa insignis						
Ozoroa paniculosa			√			
Ozoroa schinzii						
Pavetta zeyheri						
Pechuel-Loeschea leubnitziae						
Peltophorum africanum						
Philenoptera nelsii	√					LC
Rhigozum brevispinosum						
Salvadora persica						
Searsia ciliata						
Searsia marlothii						
Searsia tenuinervis		√				
Schinziophyton rautanenii					Protected (F#)	LC
Sclerocarya birrea					Protected (F#)	
Spirostachys africana	√	√	√	√	Protected (F#)	
Terminalia prunioides	√Δ	√	√Δ			
Terminalia sericea						
Vangueria infausta		√				
Veronia cinerascens						
Ximenia americana						LC
Ximenia caffra var. *caffra*						

Species: Scientific name	Species confirmed - D3007				Namibian conservation and legal status	International status (IUCN 2021)
	1	2	3	4		
Ziziphus mucronata				√	Protected (F#)	LC
Total number of species:	9	14	8	9		
Important areas:	-	-	-	-		
Invasive alien species:	-	-	-	-		
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)
√**Δ** – Dominant species
IUCN (2021): NT – Near Threatened; LC – Least Concern. All other species eitherlisted as LC or not yet been assessed for the IUCN Red List
Important areas: ENP = Etosha NP; O = Omuramba Owambo; OO = Omaramba Omuthiya
Invasive alien species: N/A
[The use of *Acacia* is made throughout rather than *Senegalia* and/or *Vachellia*]

Table 6d. Tree and shrub diversity expected and confirmed during the fieldwork at each of the 4 vegetation survey points conducted along the D3047 (5km apart) – AOI00.

Species: Scientific name	Species confirmed - D3047				Namibian conservation and legal status	International status (IUCN 2021)
	1	2	3	4		
Acacia arenaria						
Acacia ataxacantha						
Acacia erioloba	√				Protected (F#)	LC
Acacia erubescens						
Acacia fleckii						
Acacia hebeclada			√			
Acacia karroo						
Acacia kirkii						
Acacia luederitzii						
Acacia mellifera			√	√		
Acacia nebrownii						
Acacia nilotica						
Acacia reficiens	√	√	√Δ	√Δ		
Acacia senegal						

Species: Scientific name	Species confirmed - D3047				Namibian conservation and legal status	International status (IUCN 2021)
	1	2	3	4		
Acacia sieberiana						
Acacia tortilis						LC
Adenium boehmianum					Protected (F#)	
Albizia anthelmintica					Protected (F#)	LC
Aloe litoralis					NC; C2	
Baikiaea plurijuga					Protected (F#); LR-nt	NT
Baphia massaiensis						
Bauhinia petersiana						
Boscia albitrunca					Protected (F#); LR-nt	LC
Boscia foetida						
Burkea africana					Protected (F#)	LC
Catophractes alexandri						
Colophospermum mopane					Protected (F#)	
Combretum apiculatum		√	√			
Combretum celastroides						
Combretum collinum						
Combretum hereroense		√	√	√		
Combretum mosambicense						
Combretum imberbe	√			√	Protected (F#)	LC
Commiphora africana						
Commiphora angolensis						
Commiphora glandulosa	√					
Commiphora mollis						
Commiphora pyracanthoides						
Commiphora tenuipetiolata						
Cordia sinensis						
Croton gratissimus	√	√		√		
Croton menyharthii						
Dichrostachys cinerea	√	√		√		
Diospyros lycioides						
Diospyros mespiliformis					Protected (F#)	
Ehretia alba						
Ehretia namibiensis						
Elaeodendron transvaalense						
Elephantorrhiza suffruticosa						

Species: Scientific name	Species confirmed - D3047				Namibian conservation and legal status	International status (IUCN 2021)
	1	2	3	4		
Euclea divinorum						
Euclea undulata						
Ficus burkei/F. petersii					Protected (F#)	
Ficus cordata					Protected (F#)	
Ficus sycomorus					Protected (F#)	
Fockea multiflora						
Grewia avellana						
Grewia bicolor	√					
Grewia flava						
Grewia flavescens						
Grewia olukondae						
Grewia retinervis						
Grewia schinzii						
Grewia subspathulata						
Grewia tenax						
Grewia villosa						
Gossypium herbaceum						
Gossypium triphyllum						
Gymnosporia senegalensis						
Hyphaene petersiana	√	√	√		Protected (F#)	
Ipomoea adenioides						
Lycium cinereum						
Maerua schinzii					Protected (F#)	LC
Mundulea sericea						
Ozoroa insignis						
Ozoroa paniculosa		√				
Ozoroa schinzii						
Pavetta zeyheri						
Pechuel-Loeschea leubnitziae						
Peltophorum africanum						
Philenoptera nelsii	√					LC
Rhigozum brevispinosum						
Salvadora persica						
Searsia ciliata						
Searsia marlothii						

Species: Scientific name	Species confirmed - D3047				Namibian conservation and legal status	International status (IUCN 2021)
	1	2	3	4		
Searsia tenuinervis						
Schinziophyton rautanenii					Protected (F#)	LC
Sclerocarya birrea					Protected (F#)	
Spirostachys africana	√	√			Protected (F#)	
Terminalia prunioides	√Δ	√Δ		√		
Terminalia sericea						
Vangueria infausta						
Veronia cinerascens						
Ximenia americana						LC
Ximenia caffra var. *caffra*						
Ziziphus mucronata				√	Protected (F#)	LC
Total number of species:	12	9	6	8		
Important areas:	-	-	-	-		
Invasive alien species:	-	-	-	-		
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)
√**Δ** – Dominant species
IUCN (2021): NT – Near Threatened; LC – Least Concern. All other species eitherlisted as LC or not yet been assessed for the IUCN Red List
Important areas: ENP = Etosha NP; O = Omuramba Owambo; OO = Omaramba Omuthiya
Invasive alien species: N/A
[The use of *Acacia* is made throughout rather than *Senegalia* and/or *Vachellia*]

Table 6e. Tree and shrub diversity expected and confirmed during the fieldwork at each of the 4 vegetation survey points conducted along the C38 [Etosha NP section) (5km apart) – AOI00.

Species: Scientific name	Species confirmed – C38				Namibian conservation and legal status	International status (IUCN 2021)
	1	2	3	4		
Acacia arenaria						
Acacia ataxacantha						
Acacia erioloba	√	√	√		Protected (F#)	LC
Acacia erubescens						

Species: Scientific name	Species confirmed – C38				Namibian conservation and legal status	International status (IUCN 2021)
	1	2	3	4		
Acacia fleckii						
Acacia hebeclada			√			
Acacia karroo						
Acacia kirkii						
Acacia luederitzii						
Acacia mellifera						
Acacia nebrownii						
Acacia nilotica	√	√	√			
Acacia reficiens	√	√	√	√		
Acacia senegal						
Acacia sieberiana						
Acacia tortilis						LC
Adenium boehmianum					Protected (F#)	
Albizia anthelmintica					Protected (F#)	LC
Aloe litoralis					NC; C2	
Baikiaea plurijuga					Protected (F#); LR-nt	NT
Baphia massaiensis						
Bauhinia petersiana						
Boscia albitrunca		√		√	Protected (F#); LR-nt	LC
Boscia foetida						
Burkea africana					Protected (F#)	LC
Catophractes alexandri	√					
Colophospermum mopane					Protected (F#)	
Combretum apiculatum	√	√		√		
Combretum celastroides						
Combretum collinum						
Combretum hereroense	√					
Combretum mosambicense						
Combretum imberbe	√	√	√	√	Protected (F#)	LC
Commiphora africana						
Commiphora angolensis						
Commiphora glandulosa	√	√	√	√		
Commiphora mollis						
Commiphora pyracanthoides						
Commiphora tenuipetiolata						

Species: Scientific name	Species confirmed – C38				Namibian conservation and legal status	International status (IUCN 2021)
	1	2	3	4		
Cordia sinensis						
Croton gratissimus	√		√	√		
Croton menyharthii						
Dichrostachys cinerea	√	√	√	√		
Diospyros lycioides						
Diospyros mespiliformis					Protected (F#)	
Ehretia alba						
Ehretia namibiensis						
Elaeodendron transvaalense						
Elephantorrhiza suffruticosa						
Euclea divinorum						
Euclea undulata						
Ficus burkei/F. petersii					Protected (F#)	
Ficus cordata					Protected (F#)	
Ficus sycomorus					Protected (F#)	
Fockea multiflora						
Grewia avellana						
Grewia bicolor				√		
Grewia flava		√				
Grewia flavescens						
Grewia olukondae						
Grewia retinervis						
Grewia schinzii						
Grewia subspathulata						
Grewia tenax						
Grewia villosa		√				
Gossypium herbaceum						
Gossypium triphyllum						
Gymnosporia senegalensis						
Hyphaene petersiana					Protected (F#)	
Ipomoea adenioides						
Lycium cinereum						
Maerua schinzii					Protected (F#)	LC
Mundulea sericea						
Ozoroa insignis						

Species: Scientific name	Species confirmed – C38				Namibian conservation and legal status	International status (IUCN 2021)
	1	2	3	4		
Ozoroa paniculosa	√					
Ozoroa schinzii						
Pavetta zeyheri						
Pechuel-Loeschea leubnitziae			√			
Peltophorum africanum						
Philenoptera nelsii		√				LC
Rhigozum brevispinosum						
Salvadora persica						
Searsia ciliata						
Searsia marlothii						
Searsia tenuinervis						
Schinziophyton rautanenii					Protected (F#)	LC
Sclerocarya birrea					Protected (F#)	
Spirostachys africana		√Δ	√	√	Protected (F#)	
Terminalia prunioides	√Δ	√Δ	√Δ	√Δ		
Terminalia sericea						
Vangueria infausta						
Veronia cinerascens						
Ximenia americana						LC
Ximenia caffra var. *caffra*						
Ziziphus mucronata					Protected (F#)	LC
Total number of species:	13	13	11	10		
Important areas:	-	-	-	-		
Invasive alien species:	-	-	*PS*	-		
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)
√**Δ** – Dominant species
IUCN (2021): NT – Near Threatened; LC – Least Concern. All other species eitherlisted as LC or not yet been assessed for the IUCN Red List
Important areas: ENP = Etosha NP; O = Omuramba Owambo; OO = Omaramba Omuthiya
Invasive alien species: PS = *Pennisetum setaceum*
[The use of *Acacia* is made throughout rather than *Senegalia* and/or *Vachellia*]

Table 6f. Tree and shrub diversity expected and confirmed during the fieldwork at each of the 4 vegetation survey points conducted along the D3610 (10km apart) – AOI01.

Species: Scientific name	Species confirmed – D3610								Namibian conservation and legal status	International status (IUCN 2021)
	1	2	3	4	5	6	7	8		
Acacia arenaria										
Acacia ataxacantha				√			√	√		
Acacia erioloba		√Δ	√			√	√	√	Protected (F#)	LC
Acacia erubescens				√						
Acacia fleckii				√			√	√		
Acacia hebeclada										
Acacia karroo										
Acacia kirkii										
Acacia luederitzii										
Acacia mellifera	√Δ			√						
Acacia nebrownii										
Acacia nilotica										
Acacia reficiens	√	√		√						
Acacia senegal										
Acacia sieberiana										
Acacia tortilis										LC
Adenium boehmianum									Protected (F#)	
Albizia anthelmintica	√								Protected (F#)	LC
Aloe litoralis									NC; C2	
Baikiaea plurijuga									Protected (F#); LR-nt	NT
Baphia massaiensis				√Δ	√					
Bauhinia petersiana				√	√		√			
Boscia albitrunca	√	√				√	√		Protected (F#); LR-nt	LC
Boscia foetida										
Burkea africana			√		√				Protected (F#)	LC
Catophractes alexandri						√				
Colophospermum mopane									Protected (F#)	
Combretum apiculatum		√								
Combretum celastroides							√			
Combretum collinum			√	√						
Combretum hereroense			√	√Δ	√Δ			√		

Species: Scientific name	Species confirmed – D3610								Namibian conservation and legal status	International status (IUCN 2021)
	1	2	3	4	5	6	7	8		
Combretum mosambicense										
Combretum imberbe									Protected (F#)	LC
Commiphora africana										
Commiphora angolensis										
Commiphora glandulosa										
Commiphora mollis										
Commiphora pyracanthoides										
Commiphora tenuipetiolata										
Cordia sinensis										
Croton gratissimus	√		√	√	√	√Δ	√	√		
Croton menyharthii										
Dichrostachys cinerea	√	√	√		√	√Δ	√			
Diospyros lycioides										
Diospyros mespiliformis									Protected (F#)	
Ehretia alba										
Ehretia namibiensis										
Elaeodendron transvaalense										
Elephantorrhiza suffruticosa										
Euclea divinorum										
Euclea undulata										
Ficus burkei/F. petersii									Protected (F#)	
Ficus cordata									Protected (F#)	
Ficus sycomorus		√							Protected (F#)	
Fockea multiflora										
Grewia avellana										
Grewia bicolor	√					√				
Grewia flava	√						√			
Grewia flavescens										
Grewia olukondae										
Grewia retinervis										
Grewia schinzii										
Grewia subspathulata										
Grewia tenax										
Grewia villosa										

Species: Scientific name	Species confirmed – D3610								Namibian conservation and legal status	International status (IUCN 2021)
	1	2	3	4	5	6	7	8		
Gossypium herbaceum										
Gossypium triphyllum										
Gymnosporia senegalensis										
Hyphaene petersiana									Protected (F#)	
Ipomoea adenioides										
Lycium cinereum										
Maerua schinzii									Protected (F#)	LC
Mundulea sericea							√			
Ozoroa insignis										
Ozoroa paniculosa										
Ozoroa schinzii										
Pavetta zeyheri										
Pechuel-Loeschea leubnitziae	√	√								
Peltophorum africanum										
Philenoptera nelsii			√	√	√	√		√		LC
Rhigozum brevispinosum										
Salvadora persica										
Searsia ciliata										
Searsia marlothii										
Searsia tenuinervis	√									
Schinziophyton rautanenii									Protected (F#)	LC
Sclerocarya birrea									Protected (F#)	
Spirostachys africana									Protected (F#)	
Terminalia prunioides		√	√Δ							
Terminalia sericea				√Δ	√Δ		√Δ	√Δ		
Vangueria infausta										
Veronia cinerascens										
Ximenia americana										LC
Ximenia caffra var. *caffra*										
Ziziphus mucronata									Protected (F#)	LC
Total number of species:	10	8	8	12	8	7	11	7		
Important areas:	-	-	-	-	-	-	-	-		
Invasive alien species:	-	-	-	-	-	-	-	-		
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)
√**Δ** – Dominant species
IUCN (2021): NT – Near Threatened; LC – Least Concern. All other species eitherlisted as LC or not yet been assessed for the IUCN Red List
Important areas: ENP = Etosha NP; O = Omuramba Owambo; OO = Omaramba Omuthiya
Invasive alien species: N/A
[The use of *Acacia* is made throughout rather than *Senegalia* and/or *Vachellia*]

Table 6g. Tree and shrub diversity expected and confirmed during the fieldwork at each of the 4 vegetation survey points conducted along the D3659 (5km apart) – AOI01.

Species: Scientific name	Species confirmed – D3659								Namibian conservation and legal status	International status (IUCN 2021)
	1	2	3	4	5	6	7	8		
Acacia arenaria										
Acacia ataxacantha		√	√Δ	√	√					
Acacia erioloba	√	√	√					√	Protected (F#)	LC
Acacia erubescens										
Acacia fleckii		√		√	√	√				
Acacia hebeclada										
Acacia karroo										
Acacia kirkii										
Acacia luederitzii										
Acacia mellifera										
Acacia nebrownii										
Acacia nilotica	√									
Acacia reficiens		√		√						
Acacia senegal				√						
Acacia sieberiana										
Acacia tortilis										LC
Adenium boehmianum									Protected (F#)	
Albizia anthelmintica	√	√		√		√			Protected (F#)	LC
Aloe litoralis									NC; C2	
Baikiaea plurijuga					√Δ				Protected (F#); LR-nt	NT

Species: Scientific name	Species confirmed – D3659								Namibian conservation and legal status	International status (IUCN 2021)
	1	2	3	4	5	6	7	8		
Baphia massaiensis						√Δ	√			
Bauhinia petersiana		√	√	√	√	√				
Boscia albitrunca						√	√		Protected (F#); LR-nt	LC
Boscia foetida										
Burkea africana						√			Protected (F#)	LC
Catophractes alexandri										
Colophospermum mopane									Protected (F#)	
Combretum apiculatum										
Combretum celastroides										
Combretum collinum	√Δ	√	√	√			√	√		
Combretum hereroense					√	√		√		
Combretum mosambicense										
Combretum imberbe									Protected (F#)	LC
Commiphora africana										
Commiphora angolensis										
Commiphora glandulosa					√	√				
Commiphora mollis										
Commiphora pyracanthoides										
Commiphora tenuipetiolata										
Cordia sinensis										
Croton gratissimus		√	√	√	√	√	√	√		
Croton menyharthii										
Dichrostachys cinerea		√Δ	√	√	√	√	√Δ	√Δ		
Diospyros lycioides					√		√			
Diospyros mespiliformis									Protected (F#)	
Ehretia alba										
Ehretia namibiensis										
Elaeodendron transvaalense										
Elephantorrhiza suffruticosa										
Euclea divinorum										
Euclea undulata										
Ficus burkei/F. petersii									Protected (F#)	
Ficus cordata									Protected (F#)	
Ficus sycomorus									Protected (F#)	

Species: Scientific name	Species confirmed – D3659								Namibian conservation and legal status	International status (IUCN 2021)
	1	2	3	4	5	6	7	8		
Fockea multiflora										
Grewia avellana										
Grewia bicolor	√									
Grewia flava			√	√	√					
Grewia flavescens										
Grewia olukondae										
Grewia retinervis										
Grewia schinzii										
Grewia subspathulata										
Grewia tenax										
Grewia villosa										
Gossypium herbaceum										
Gossypium triphyllum										
Gymnosporia senegalensis										
Hyphaene petersiana									Protected (F#)	
Ipomoea adenioides										
Lycium cinereum										
Maerua schinzii					√	√		√	Protected (F#)	LC
Mundulea sericea										
Ozoroa insignis										
Ozoroa paniculosa										
Ozoroa schinzii										
Pavetta zeyheri										
Pechuel-Loeschea leubnitziae										
Peltophorum africanum										
Philenoptera nelsii	√		√	√		√	√	√		LC
Rhigozum brevispinosum										
Salvadora persica										
Searsia ciliata										
Searsia marlothii										
Searsia tenuinervis										
Schinziophyton rautanenii									Protected (F#)	LC
Sclerocarya birrea									Protected (F#)	
Spirostachys africana									Protected (F#)	

Species: Scientific name	Species confirmed – D3659								Namibian conservation and legal status	International status (IUCN 2021)
	1	2	3	4	5	6	7	8		
Terminalia prunioides	√	√								
Terminalia sericea			√	√Δ		√Δ	√Δ	√Δ		
Vangueria infausta										
Veronia cinerascens										
Ximenia americana										LC
Ximenia caffra var. *caffra*										
Ziziphus mucronata									Protected (F#)	LC
Total number of species:	7	9	10	12	11	12	9	8		
Important areas:	-	-	-	-	-	-	-	-		
Invasive alien species:	-	-	-	-	-	-	-	-		
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)
√**Δ** – Dominant species
IUCN (2021): NT – Near Threatened; LC – Least Concern. All other species eitherlisted as LC or not yet been assessed for the IUCN Red List
Important areas: ENP = Etosha NP; O = Omuramba Owambo; OO = Omaramba Omuthiya
Invasive alien species: N/A
[The use of *Acacia* is made throughout rather than *Senegalia* and/or *Vachellia*]

Figure 9. *Baikiaea plurijuga* (Zambezi teak – Near Threatened, IUCN 2021) – protected – has been targeted extensively for illegal logging purposes (AOI01).

Figure 10. *Burkea africana* (burkea) – protected – are some of the taller trees in the area and are targeted for timber and firewood production (AOI02).

Figure 11. *Combretum imberbe* (leadwood) – protected – are some of the larger and more important protected tree species in the area (AOI00).

Figure 12. *Hyphaene petersiana* (makalani) – protected – stands are often nesting sites for vultures and other large raptors in the general area (AOI00).

Figure 13. *Sclerocarya birrea* (maroela) – protected – are important fruit trees.

Figure 14. *Spirostachys africana* (tamboti) – protected – are important trees for fence poles and droppers as they are termite resistant.

The most important areas are viewed as the Omuramba Owambo; Omuramba Omuthiya other Omuramba's and pans throughout the general AOI (See Figures 4-5).

AOI00

The most dominant tree and shrub species throughout the AOI00 are *Acacia mellifera* (black thorn), *Acacia reficiens* (red-bark Acacia), *Combretum apiculatum* (kudu bush), *Combretum hereroense* (mouse-eared Combretum), *Dichrostachys cinerea* (sicklebush), *Spirostachys africana* (tamboti) and *Terminalia sericea* (silver cluster leaf) (Figure 15).

AOI01

The most dominant tree and shrub species throughout the AOI00 are *Acacia erioloba* (camel thorn), *Acacia mellifera* (black thorn), *Baphia massaiensis* (sand camwood), *Combretum hereroense* (mouse-eared Combretum) and *Terminalia sericea* (silver cluster leaf) (Figures 16).

AOI02

The most dominant tree and shrub species throughout the AOI00 are *Acacia ataxacantha* (flame thorn), *Baikiaea plurijuga* (Zambezi teak), *Baphia massaiensis* (sand camwood), *Combretum collinum* (variable Combretum), *Dichrostachys cinerea* (sicklebush) and *Terminalia sericea* (silver cluster leaf) (Figures 17).

Figure 15. Dense impenetrable stands of *Dichrostachys cinerea* (sicklebush) are dominant in large parts of the AOI00.

Figure 16. *Terminalia sericea* (silver cluster leaf) is dominant in the AOI01.

Figure 17. *Acacia ataxacantha* (flame thorn) and *Combretum collinum* (variable Combretum) are some of the dominant species in die sandy AOI02.

The general area has been heavily impacted in places, especially close to towns, villages and settlements such as Oshivelo, etc.; crop production and land clearing on freehold farms; subsistence farming activities in communal areas, etc. and none of the unique trees and shrubs are expected to be exclusively associated with the seismic survey routes in AOI00, AOI01 and AOI02. The proposed mitigations – See Section 4 – are expected to minimise the overall effect on amphibians potentially occurring in the area.

Impact of extension of seismic lines along existing roads/tracks:
A typical weight drop would have a peak force output of 860,000lbs (~430,000kg) at base plate 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 and 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 and shrubs in the general area.

A single vibrator truck can generate more than 178 N (Newton of ground force), and usually four trucks are clustered together to create the energy at each source point, creating a combined ground force of 667 to 890 kN (kilonewton of ground force). A seismic vibrator transforms the energy provided by a diesel engine into a vibration. It is performed by a shaker, a movable element that generates the vibration, thanks to a piston-reaction mass device driven by an electro hydraulic servo valve. The shaker is applied to the ground for each vibration and then raised up so that the seismic vibrator can move to another vibrating point. Vibroseis do not cause any disturbance except for the need to widen the track and for a light terrain vibration to be felt and read by the geophones – i.e. no explosives are required. Although the precise impact of using this technology on trees and shrubs is unknown, disturbances would be of short duration and it is not expected that the ground seismic survey, using vibroseis technology, will have any lasting negative impacts on trees and shrubs 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, the extension of seismic line 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 should new track(s) have been commissioned.

Impact of new seismic lines:
Habitat destruction would occur along new routes envisaged. The widening and upgrading of the existing sandy tracks is also expected to contribute to habitat destruction/alteration. Habitat destruction, due to the creation and widening of new tracks, especially through the Omuramba Owambo and Omuthiya (and other ephemeral drainage lines and pans), is more important although the actual footprint is small. Increased traffic along these new access routes 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 93 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 [18spp.], Müller 2007 [48spp.], Van Oudshoorn 1999 [96spp.]) – approximate total of 116 species – occur in the general PEL 93 area.

The grasses known and/or expected to occur in the general area ([1]Müller 2007, [2]Van Oudtshoorn 1999 and [3]Müller 1984) is presented in Table 7 below.

Table 7. Grass diversity expected (literature study) and confirmed (fieldwork) along various tracks in the general AOI (i.e. general seismic survey routes) (See Figure 1).

Species: Scientific name	Species confirmed			Namibian conservation and legal status	Ecological Status	Grazing Value
	AOI00	AOI01	AOI02			
[2]*Acroceras macrum*					Decreaser	High
[2]*Andropogon chinensis*					Increaser 1	Average
[2]*Andropogon eucomus*					Increaser 2	Low
[1,2]*Andropogon gayanus*	√				Increaser 1	High
[2]*Andropogon huillensis*					Increaser 1	Average
[2]*Andropogon schirensis*					Increaser 1	Average
[2]*Anthephora pubescens*	√				Decreaser	High
[1]*Anthephora schinzii*			√			
[2]*Aristida adscensionis*	√Δ	√			Increaser 2	Low
[1,2,3]*Aristida congesta*	√		√		Increaser 2	Low
[2]*Aristida junciformis*					Increaser 2	Low
[1,2,3]*Aristida meridionalis*	√Δ		√		Increaser 2	Low
[3]*Aristida pilgeri*					Increaser 2	Low
[2]*Aristida rhiniochloa*					Increaser 2	Low
[2]*Aristida scabrivalvis*					Increaser 2	Low
[1,2,3]*Aristida stipitata*					Increaser 2	Low
[1]*Aristida stipoides*					?	Low
[2]*Bothriochloa bladhii*					Increaser 1	Low
[2]*Bothriochloa insculpta*					Increaser 2	Average
[2]*Bothriochloa radicans*					Increaser 2	Low
[2]*Brachiaria brizantha*					Increaser 1	Average
[1,2,3]*Bachiaria deflexa*					Increaser 2	Average

Species: Scientific name	Species confirmed			Namibian conservation and legal status	Ecological Status	Grazing Value
	AOI00	AOI01	AOI02			
[1]*Brachiaria dura*					?	Average
[2]*Bachiaria eruciformis*					Increaser 2	Average
[1,2,3]*Brachiaria nigropedata*					Decreaser	High
[1]*Brachiaria schoenfelderi*	√					
[1,2,3]*Cenchrus ciliaris*	√	√			Decreaser	High
[1,2,3]*Chloris virgata*	√	√			Increaser 2	Average
[2]*Chloris gayana*					Decreaser	High
[1,3]*Cymbopogon caesius*	√				?	Low
[2]*Cymbopogon excavatus*					Increaser 1	Low
[1,2,3]*Cynodon dactylon*	√				Increaser 2	High
[2]*Dactyloctenium aegyptium*		√			Increaser 2	Low
[1,2,3]*Dactyloctenium giganteum*	√	√Δ			Increaser 2	Low
[1,2]*Dichanthium annulatum*	√				Decreaser	High
[2]*Digitaria eriantha*					Decreaser	High
[2]*Digitaria sanguinalis*					Increaser 2	Low
[1]*Digitaria seriata*	√	√	√Δ			
[2]*Digitaria velutina*					Increaser 2	Low
[2]*Diplachne fusca*					Decreaser	High
[1,2]*Echinochloa colona*					Increaser 2	Low
[2]*Echinochloa holubii*					Increaser 2	Average
[2]*Echinochloa pyramidalis*					Decreaser	Average
[2]*Eleusine coracana*					Increaser 2	Low
[2,3]*Elionurus muticus*					Increaser 2	Low
[2]*Enneapogon cenchroides*	√Δ	√			Increaser 2	Low
[2]*Enneapogon desvauxii*					Intermediate	Average
[2]*Enteropogon macrostachyus*					Decreaser	High
[2]*Eragrostis aspera*					Increaser 2	Low
[2]*Eragrostis cilianensis*					Increaser 2	Low
[1]*Eragrostis cylindriflora*	√	√				
[2]*Eragrostis echinochloidea*	√				Increaser 2	Average
[2]*Eragrostis gummiflua*					Increaser 2	Low
[2]*Eragrostis heteromera*					Intermediate	Low
[2]*Eragrostis inamoena*					Increaser 2	Low
[1,2]*Eragrostis lehmanniana*					Increaser 2	Average
[2]*Eragrostis nindensis*	√				Increaser 2	Average
[1,2,3]*Eragrostis pallens*					Increaser 2	Low
[1]*Eragrostis porosa*					Intermediate	Low
[1,2]*Eragrostis rigidior*					Increaser 2	Average
[2]*Eragrostis rotifer*	√				Intermediate	Low
[1,2]*Eragrostis superba*	√Δ	√			Increaser 2	Average
[2]*Eragrostis trichophora*	√Δ	√Δ	√		Increaser 2	Average
[2]*Eragrostis viscosa*					Increaser 2	Low
[2]*Eriochloa meyeriana*					Decreaser	High
[1]*Fingerhuthia africana*	√					
[2]*Hemarthria altissima*					Decreaser	High
[1,2]*Heteropogon contortus*	√Δ				Increaser 2	Average
[1]*Heteropogon melanocarpus*					?	Low
[1]*Hyparrhenia rufa*					?	Low
[1,2]*Hyperthelia dissoluta*					Increaser 1	Low
[2]*Imperata cylindrica*					Increaser 1	Low
[2]*Ischaemum fasciculatum*					Increaser 1	Average
[2]*Ischaemum afrum*					Intermediate	Average
[2]*Leersia hexandra*					?	High
[1]*Leptochloa fusca*					?	Average

Species: Scientific name	Species confirmed			Namibian conservation and legal status	Ecological Status	Grazing Value
	AOI00	AOI01	AOI02			
[2]*Miscanthus junceus*					Increaser 1	Low
[1,2]*Melinis repens*	√	√	√		Increaser 2	Low
[3]*Melinis villosum*					?	Low
[1,2]*Panicum coloratum*	√	√			Decreaser	High
[1,3]*Panicum kalaharense*					?	Average
[1,2,3]*Panicum maximum*		√			Decreaser	High
[1,2]*Panicum repens*					Decreaser	High
[2]*Paspalum scrobiculatum*					Increaser 2	Average
[1,2,3]*Perotis patens*			√		Increaser 2	Low
[1,3]*Pogonarthria fleckii*		√	√		Increaser 2	Low
[2,3]*Pogonarthria squarrosa*					Increaser 2	Low
[1,2]*Schmidtia kalahariensis*					Increaser 2	Low
[1,2,3]*Schmidtia pappophoroides*	√				Decreaser	High
[1,3]*Schizachyrium exile*					?	Low
[2]*Schizachyrium jeffreysii*					Increaser 1	Low
[2]*Schizachyrium sanguineum*					Increaser 1	Low
[1,2]*Setaria sagittifolia*					Increaser 2	Low
[2]*Setaria sphacelata*					Decreaser	High
[2]*Setaria verticillata*					Increaser 2	Average
[2]*Sorghum bicolor*					Intermediate	High
[2]*Sorghum versicolor*					Increaser 2	Average
[2]*Sporobolus africanus*					Increaser 2	Low
[2]*Sporobolus festivus*					Increaser 2	Low
[1,2,3]*Sporobolus fimbriatus*					Decreaser	High
[1,2,3]*Sporobolus ioclados*					Increaser 2	Average
[2]*Sporobolus stapfianus*					Increaser 2	Low
[2]*Sporobolus panicoides*					Increaser 2	Low
[2]*Sporobolus pyramidalis*					Increaser 2	Low
[2]*Stipagrostis hirtigluma*					Increaser 2	Low
[1,2]*Stipagrostis uniplumis*	√Δ	√			Increaser 2	Average
[2]*Themeda triandra*					Decreaser	Average
[2]*Trachypogon spicatus*					Increaser 1	Low
[2]*Tricholaena monachne*					Increaser 2	Average
[2]*Trichoneura grandiglumis*					Increaser 2	Low
[1,2]*Tragus berteronianus*	√	√Δ	√		Increaser 2	Low
[1]*Urochloa brachyura*	√Δ	√	√Δ		?	Average
[2]*Urochloa mosambicensis*					Increaser 2	High
[2]*Urochloa oligotricha*					Decreaser	High
[1]*Urochloa trichopus*					?	Low
[1]*Willkommia sarmentosa*					?	Low
Totals	**28**	**17**	**10**			

? – not classified in literature, but often similar to other species within the genus

Source for literature review: [1]Müller (1984), [2]Müller (2007), [3]Van Oudtshoorn (1999)

Although up to 116 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 – *Eragrostis pallens* and *Cymbopogon* species – which also have economic value, are the important grasses in the area.

During the fieldwork a total of 33 grasses were confirmed from the various AOI with the AOI00 (28spp.) having the highest species diversity followed by the AOI01 (17spp.) and the AOI02 (10spp.) (See Table 7). The AOI02 is heavily overgrazed throughout with the D3659 serving as a cattle thoroughfare between fields and communal farms. Dense stands of grass occur in open areas and/or along road verges in the AOI00 and AOI01 (Figures 18-19).

The most dominant grass species throughout the AOI00 (dependent on soil, grazing regime, fire frequency, bush densities, etc.) are *Aristida adscensionis* (annual bristle-grass), *Aristida meridionalis* (giant bristle-grass), *Enneapogon cenchroides* (common nine-awned grass), *Eragrostis superba* (heartseed love-grass), *Eragrostis trichophora* (smooth love-grass), *Heteropogon contortus* (spear grass), *Stipagrostis uniplumis* (silky Bushman-grass) and *Urochloa brachyura*. *Dactyloctenium giganteum* (giant crowfoot), *Eragrostis trichophora* (smooth love-grass) and *Tragus berteronianus* (small carrotseed grass) are dominant in the AOI01 while *Digitaria seriata* (Kuruman finger grass) and *Urochloa brachyura* are dominant in the AOI02.

The general area has been heavily impacted in places, especially close to towns, villages and settlements such as Oshivelo, etc.; crop production and land clearing on freehold farms; subsistence farming activities in communal areas, etc. and none of the unique grasses are expected to be exclusively associated with the seismic survey routes in AOI00, AOI01 and AOI02. The proposed mitigations – See Section 4 – are expected to minimise the overall effect on amphibians potentially occurring in the area.

Figure 18. A large variety of perennial grass species are found in the AOI00.

Figure 19. *Dactyloctenium giganteum* (giant crowfoot) are dominant in open areas in the AOI02.

Impact of extension of seismic lines along existing roads/tracks:
A typical weight drop would have a peak force output of 860,000lbs (~430,000kg) at base plate 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 grass species 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.

A single vibrator truck can generate more than 178 N (Newton of ground force), and usually four trucks are clustered together to create the energy at each source point, creating a combined ground force of 667 to 890 kN (kilonewton of ground force). A seismic vibrator transforms the energy provided by a diesel engine into a vibration. It is performed by a shaker, a movable element that generates the vibration, thanks to a piston-reaction mass device driven by an electro hydraulic servo valve. The shaker is applied to the ground for each vibration and then raised up so that the seismic vibrator can move to another vibrating point. Vibroseis do not cause any disturbance except for the need to widen the track and for a light terrain vibration to be felt and read by the geophones – i.e. no explosives are required. 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 vibroseis technology, will have any lasting negative impacts on grasses 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, the extension of seismic line 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 should a new track have been commissioned.

Impact of new seismic lines:
Habitat destruction would occur along new routes envisaged. The widening and upgrading of the existing sandy tracks is also expected to contribute to habitat destruction/alteration. Habitat destruction, due to the creation and widening of new tracks, especially through the

Omuramba Owambo and Omuthiya (and other ephemeral drainage lines and pans), is more important although the actual footprint is small. Increased traffic along these new access routes could lead to increased slash-and-burn practices for agricultural purposes and 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 1 other species not included in Table 5 – e.g. *Aloe esculenta* – occur in the general area and may occur in the PEL 93 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, but not listed in Table 5, include *Commiphora glaucescens* (Steyn 2003). Although a few *Commiphora* spp. were observed during the fieldwork (See Tables 5 and 6) the above mentioned species was 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 13 indigenous species (*Actiniopteris radiata*, *Cheilanthes dinteri, C. marlothii*, *Doryopteris concolor*, *Marsilea aegyptiaca, M. farinosa, M. macrocarpa, M. nubica*, *M. unicornis*, *M. vera*, *Ophioglossum polyphyllum, O. reticulatum* and *Pellaea calomelanos*) and no endemics (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 2000's 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/zeyheri* (devil's claw) which potentially have a huge economic benefit (Mendelsohn *et al.* 2002). *Harpagophytum zeyheri* (devil's claw) individuals were observed, associated with sandy soils, in the AOI02 (Figure 20).

Figure 20. *Harpagophytum zeyheri* (devil's claw) observed in the AOI02.

Invasive alien species
Invasive alien species observed during the fieldwork was limited to *Pennisetum setaceum* (fountain grass) on the road verge along the C33 towards the Etosha National Park (Figure 21).

Figure 21. A population (~100 plants) of the invasive alien *Pennisetum setaceum* (fountain grass) was observed along the tarmac road to the Etosha National Park.

3.8 Important Species

Reptiles
The most important species know/expected to occur in the general area would be the 2 species classified as rare (*Gonionotophis (Mehelya) vernayi*, *Sepsina angolensis*); 4 species classified as vulnerable (*Stigmochelys pardalis*, *Psammobates oculiferus*, *Python natalensis*, *Varanus albigularis*); 4 species classified as protected game (*Stigmochelys pardalis*, *Psammobates oculiferus*, *Python natalensis*, *Varanus albigularis*); 1 species classified as insufficiently known (*Gonionotophis (Mehelya) vernayi*) and 1 species classified as indeterminate (*Sepsina angolensis*).

Amphibians
The most important species from the area is the giant bullfrog (*Pyxicephalus adspersus*) with "populations are decreasing" according to the IUCN (2021) as it is consumed as food throughout its range (Griffin *pers. com.*). Most amphibians are expected to be associated with the ephemeral Omuramba Owambo and Omuthiya and various smaller pans throughout the general area.

Mammals
The most important species from the general area are probably those classified as rare (*Kerivoula lanosa*, *Zelotomys woosnami*, *Atelerix frontalis angolae*, *Civittictis civetta*), endangered (*Lycaon pictus*, *Equus (burchellii) quagga*) and vulnerable, under Namibian legislation and those classified by the IUCN (2021) as endangered (*Loxodonta africana*, *Lycaon pictus*), vulnerable (*Smutsia (Manis) temminckii*, *Acinonyx jubatus*, *Panthera pardus*, *Panthera leo*, *Aepyceros melampus petersi*) and near threatened (*Macronycteris (Hipposideros) vittatus*, *Parahyaena (Hyaena) brunnea*). However, some of the above species – e.g. elephant, wild dog, etc. – only pass through the area – or are associated with game farms – zebra, black-faced impala – (i.e. introduced onto farms in the AOI00). 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 the 7 endemics and those classified as critically endangered (grey crowned crane, blue crane), endangered (southern ground-hornbill, Lüdwig's bustard, wattled crane, hooded vulture, white-backed vulture, bateleur, tawny eagle, booted eagle, martial eagle, yellow-billed oxpecker), vulnerable (lappet-faced vulture, white-headed vulture, secretarybird) and near threatened (Rüppell's Parrot, kori bustard, Verreauxs' Eagle, peregrine falcon, marabou stork) from Namibia (Simmons *et al.* 2015) and those classified by the IUCN (2021) as critically endangered (hooded vulture, white-headed vulture, white-backed vulture), endangered (Ludwig's bustard, grey crowned crane, lappet-faced vulture, bateleur, martial eagle, secretarybird), vulnerable (southern ground-hornbill, blue crane, wattled crane, tawny eagle) and near threatened (kori bustard). An important species confirmed from the general area is the yellow-billed oxpecker. Although oxpecker numbers have increased in communal areas in northern Namibia (Robertson and Jarvis 2000), elsewhere they have been negatively affected due to arsenic-based cattle dips.

Trees/shrubs
The most important larger tree and shrub species expected to occur in the general area include all those formally protected (See Tables 5 and 6a-g) with the most important species viewed as *Baikiaea plurijuga*, *Burkea africana* and *Sclerocarya birrea.* Of these, the most important species is *Baikiaea plurijuga* (Zambezi/Rhodesian Teak) due to numbers having decreased due to overutilization for wood production; elephant damage and unseasonal human induced fires.

Grass
The grasses commonly used for thatching – *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. Ephemeral Omuramba Owambo and Omuthiya

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). In a sandy area with very little surface water, these rivers are seasonal lifelines and habitat to numerous vertebrates (Figure 22).

2. 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). The Etosha pans and various other smaller pans in the greater Omudhiya Lakes area are also viewed as important habitat to a variety of aquatic birds and the critically endangered cranes.

3. Etosha National Park

The Etosha NP on the western boundary of the AOI is the flagship of the parks in Namibia with hundreds of species of mammals, birds and reptiles, including several threatened and endangered species such as black rhino, cheetah, elephant, lion, white rhino, etc. as well as a breeding site for the critically endangered blue crane (Ntinda *et al.* 2012; See: www.met.gov.na) (Figure 22).

4. Mangetti Block

The Mangetti Block is located to the immediate east of the AOI and is important as an elephant migration route between the Etosha NP and the Okavango River (and Angola) and the Mangetti and Kaudum NP's including a small wild dog population which also occurs in this area (Figure 22).

5. 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.), north of the Veterinary Cordon (i.e. communal area) and more recently along the various tracks and roads throughout the area, including long term farming impacts on freehold farms south of Oshivelo. However, there are some areas far from the 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, the seismic surveying will mostly be conducted on existing access routes throughout the area.

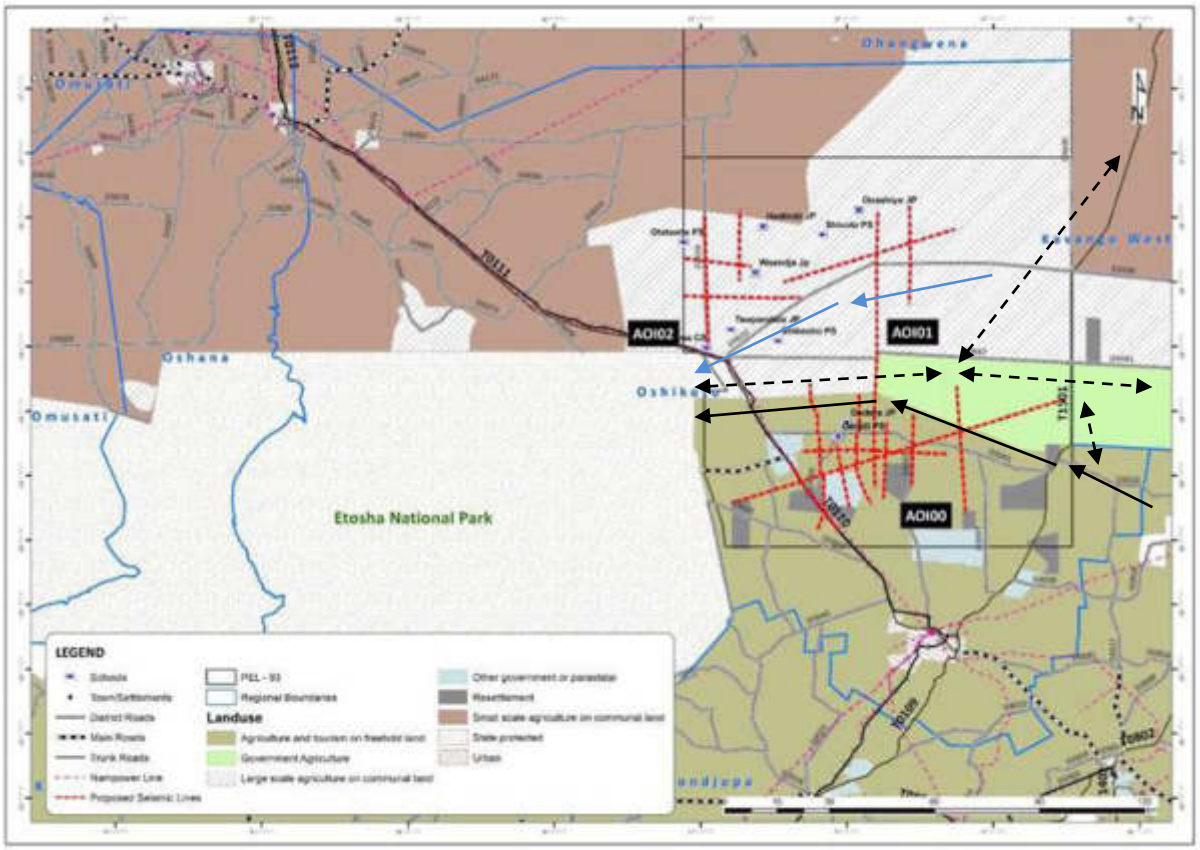

Figure 22. Important habitats in the general area are: Omuramba Owambo (black arrows); Omuramba Omuthiya (blue arrows); Etosha National Park (white shade) and the Mangetti Block (green shade). Elephant movement between the Etosha National Park and the Mangetti farms are indicated (dotted black arrows). The red dotted lines are the various seismic routes (AOI00, AOI01 & AOI02) (ReconAfrica).

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):

Description	Faunal disturbance will vary depending on the scale/intensity of the seismic operations.
Extent	**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. [No new tracks/roads will be created as seismic surveying will be conducted on existing access routes throughout the area]

Duration	**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.
Intensity	**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 & other associated disturbances in the area, but be limited to the road clearing and seismic activity periods.
Mitigation	**General** **1.** Limit the development to actual tracks/roads to be cleared and avoid affecting adjacent areas, especially the Omaramba Owambo and Omuthiya and other ephemeral drainage lines and pans, throughout the entire area. **2.** Avoid development & associated infrastructure in sensitive areas – e.g. Omaramba Owambo and Omuthiya and 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) – as this could easily cause runaway veld fires affecting the local fauna, but also causing problems (e.g. loss of grazing & 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. **8.** Prevent domestic pets – e.g. cats & dogs – 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 Oshivelo/Tsumeb and not store on site) as this often attracts wildlife – e.g. 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 Etosha National Park and the Mangetti Block. **Tracks/Roads – General** **13.** Avoid placing tracks/roads trough 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. **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 – e.g. 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 discipline"), 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 "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 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. Highly Probable (75%) negative impact on fauna is expected in the general areas especially during the construction phase(s) as a result of noise,

	increased activities, etc. Probable (50%) 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.
Significance	Before mitigation: **High** After mitigation: **Medium** to **Low**
Status of the impact	Negative Localised unique habitats (e.g. Omaramba Owambo & Omuthiya; 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).
Legal requirements	Fauna related: Nature Conservation Ordinance No. 4 of 1975, CITES, IUCN and SARDB 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 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):

Description	Floral disturbance will vary depending on the scale/intensity of the seismic operations.
Extent	**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. [No new tracks/roads will be created as seismic surveying will be conducted on existing access routes throughout the area]
Duration	**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.
Intensity	**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 & other

	associated disturbances in the area, but be limited to the road clearing and seismic activity periods.
Mitigation	**General** **1.** Limit the development to actual tracks/roads to be cleared and avoid affecting adjacent areas, especially the Omaramba Owambo and Omuthiya and other ephemeral drainage lines and pans, throughout the entire area. **2.** Avoid development & associated infrastructure in sensitive areas – e.g. Omaramba Owambo and Omuthiya; 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. **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. **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. **5.** Attempt to avoid the removal of bigger trees (especially fruit trees – e.g. *S. birrea*, etc.) 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. **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 & 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/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. **8.** Eradicate – destroy – all invasive alien plants encountered on site – e.g. *Pennisetum setacuem*, etc. (See Figure 21). This would ensure that the spread is limited and show environmental commitment. **9.** Educate/inform contractors and staff on protected species (See Tables 5 & 6 and Section 3.8) to avoid and the consequences of illegal collection of such species. **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 Etosha National Park and Mangetti Block.

	Tracks/Roads – General **12.** Avoid placing tracks/roads trough 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 – e.g. 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 discipline"), 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** After mitigation: **Medium** to **Low**
Status of the impact	Negative Localised unique habitats (e.g. Omaramba Owambo & Omuthiya; 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 65 species of reptile, 17 amphibian, 97 mammal and 250 bird species (breeding residents), at least 95 species of larger trees and shrubs (>1m in height) and up to 116 species of grasses are known to or expected to occur in the general PEL 93 area. Although there are not as many endemic vertebrate fauna species in this area as in other parts of Namibia the Etosha and pan wetland habitats and species associated with these habitats face numerous challenges due to the high density of humans in the general area.

Reptiles
The most important species know/expected to occur in the general area would be the 2 species classified as rare (*Gonionotophis (Mehelya) vernayi*, *Sepsina angolensis*); 4 species classified as vulnerable (*Stigmochelys pardalis*, *Psammobates oculiferus*, *Python natalensis*, *Varanus albigularis*); 4 species classified as protected game (*Stigmochelys pardalis*, *Psammobates oculiferus*, *Python natalensis*, *Varanus albigularis*); 1 species classified as insufficiently known (*Gonionotophis (Mehelya) vernayi*) and 1 species classified as indeterminate (*Sepsina angolensis*).

Amphibians
The most important species from the area is the giant bullfrog (*Pyxicephalus adspersus*) with "populations are decreasing" according to the IUCN (2021) as it is consumed as food throughout its range (Griffin *pers. com.*). Most amphibians are expected to be associated with the ephemeral Omuramba Owambo and Omuthiya and various smaller pans throughout the general area.

Mammals
The most important species from the general area are probably those classified as rare (*Kerivoula lanosa*, *Zelotomys woosnami*, *Atelerix frontalis angolae*, *Civittictis civetta*), endangered (*Lycaon pictus*, *Equus (burchellii) quagga*) and vulnerable, under Namibian legislation and those classified by the IUCN (2021) as endangered (*Loxodonta africana*, *Lycaon pictus*), vulnerable (*Smutsia (Manis) temminckii*, *Acinonyx jubatus*, *Panthera pardus*, *Panthera leo*, *Aepyceros melampus petersi*) and near threatened (*Macronycteris (Hipposideros) vittatus*, *Parahyaena (Hyaena) brunnea*). However, some of the above species – e.g. elephant, wild dog, etc. – only pass through the area – or are associated with game farms – zebra, black-faced impala – (i.e. introduced onto farms in the AOI00). 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 the 7 endemics and those classified as critically endangered (grey crowned crane, blue crane), endangered (southern ground-hornbill, Lüdwig's bustard, wattled crane, hooded vulture, white-backed vulture, bateleur, tawny eagle, booted eagle, martial eagle, yellow-billed oxpecker), vulnerable (lappet-faced vulture, white-headed vulture, secretarybird) and near threatened (Rüppell's Parrot, kori bustard, Verreauxs' Eagle, peregrine falcon, marabou stork) from Namibia (Simmons *et al.* 2015) and those classified by the IUCN (2021) as critically endangered (hooded vulture, white-headed vulture, white-backed vulture), endangered (Ludwig's bustard, grey crowned crane, lappet-faced vulture, bateleur, martial eagle, secretarybird), vulnerable (southern ground-hornbill, blue crane, wattled crane, tawny eagle) and near threatened (kori bustard). An important species confirmed from the general area is the yellow-billed oxpecker. Although oxpecker numbers have increased in communal areas in northern Namibia (Robertson and Jarvis 2000), elsewhere they have been negatively affected due to arsenic-based cattle dips.

Trees/shrubs
The most important larger tree and shrub species expected to occur in the general area include all those formally protected (See Tables 5 and 6a-g) with the most important species viewed as *Baikiaea plurijuga*, *Burkea africana* and *Sclerocarya birrea.* Of these, the most important species is *Baikiaea plurijuga* (Zambezi/Rhodesian Teak) due to numbers having decreased due to overutilization for wood production; elephant damage and unseasonal human induced fires.

Grass
The grasses commonly used for thatching – *Eragrostis pallens* and *Cymbopogon* species – which also have economic value, are the important grasses in the area.

All human induced activities – including exploration activities – 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, and/or seismic vibrator truck(s) activities throughout the PEL 93 area will adversely affect any unique vertebrate fauna and flora, especially if the proposed recommendations (mitigation measures) are incorporated. Although a few new track/roads are to be created, most of the survey work would use existing access routes only.

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 while the recommended mitigations should be followed to minimise the expected impacts throughout (See Section 4).

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THE SOCIOECONOMIC PROFILE

FOR

THE PROPOSED 2D SEISMIC SURVEY AREA IN THE PETROLEUM EXPLORATION LICENSE (PEL) 93 COVERING BLOCKS 1717 AND 1817 IN THE OSHIKOTO REGION, NAMIBIA

March 2022

Report By:

DR. VITA STANKEVICA (PhD, MSc, BSc)

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1 INTRODUCTION

Monitor Exploration Ltd (MEL) (the proponent) holds 75% interest in the petroleum exploration rights under the Petroleum Exploration License (PEL) No. 93 covering the latitude and longitude degree square Blocks 1817 and 1717. The remaining 15% is held by a local partner and 10% is held by the National Petroleum Corporation of Namibia (Namcor), a State owned company (Parastatal), with costs carried to the development stage.

Monitor Exploration Ltd (MEL) is the main operator of the license situated in the area of 18,500 sqkm over the heart of the Owambo basin in north east of Namibia.

The potential 580 km long 2D seismic survey areas has been identified within PEL 93 Blocks 1817 and will be conducted, using as much as possible existing roads, minor access roads, tracks and fences.

The following are the locations of the each of the proposed 2D seismic survey (*Figure 1)*:

- AOI-02 north of Oshivelo
- AOI-01 north-east of Oshivelo
- AOI-00 south-east of Oshivelo

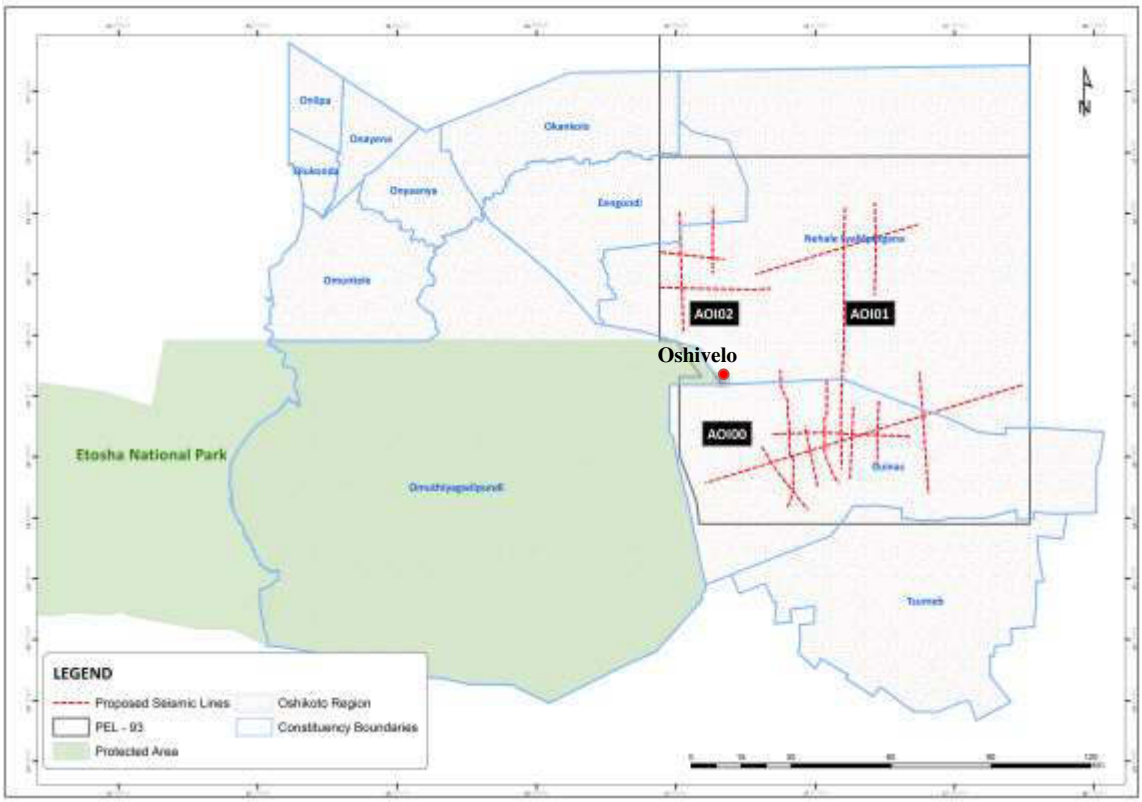

Figure 1: Location of the proposed 2D seismic survey lines within Oshikoto Region

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.

All proposed 2D seismic survey lines are located withing the boundaries of three constituencies of the Otjikoto Region, namely Guinas, Nehale LyaMpingana and a minor area within the Eengodi Constituency.

Oshikoto Region is one of only three regions without either a shoreline or a foreign border in Namibia. It borders Ohangwena, Kavango West, Otjozondjupa, Kunene and Oshana Regions.

The total population of Oshikoto Region is over 182 000 inhabitants. The region's population has grown significantly over the past years, partly as a result of redistribution within the Oshiwambo-speaking area. Apart from Tsumeb and Oniipa, people have settled in a corridor along the trunk road, occasionally forming fairly dense concentrations.

The capital town of Omuthiya is situated near the Etosha National Park, the country's biggest tourist attraction offering spectacular wildlife viewing. Oshikoto is known for its oldest copper mine situated in one of its vibrant town Tsumeb which is the largest town and previous capital of Oshana Region. The underground water which is found in the area of Tsumeb and Oshivelo makes Oshikoto Region a successful area for fruits and vegetables production. Agricultural activities, both communal and commercial in the area have opened up a window of hope for crop and livestock farming in the region.

The socio-economic report entails the relevant information on the social and economic environment of the communities living around the 2D seismic survey area in the Oshikoto Region. The information and data used for this report is derived mainly from the secondary data sources.

2 METHODS

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 January 2022 and 4th March 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 for Oshikoto Region, Namibia Inter-censal Demographic Survey 2016 Report, Namibia Labour Force Survey 2016 and 2018 Reports and Oshikoto Regional Development Profile 2020 among others.

The national Census was completed in 2011 and it presents data for 10 constituencies in Oshikoto region. Since then the Oshikoto Region has gained an additional constituency as a result of the work of the 4th Delimitation Commission. It was formed with the separation from three constituencies - Guinas, Eengodi and Okankolo. The new constituency was named after one of the Ondonga traditional chiefs Nehale LyaMpingana, and the centre of this constituency is Okoloti. The Nehale LyaMpingana constituency is bordered by four other constituencies namely, Guinas, Omuthiyagwiipundi, Eengodi and Okankolo. Thus, today Oshikoto Region has 11 constituencies, namely: Eengodi, Guinas, Nehale LyaMpingana, Okankolo, Olukonda, Omuntele, Omuthiyagwiipundi, Onayena, Oniipa, Onyaanya, and Tsumeb constituency.

The socio economic assessment determines the existing socio-economic environment of the surrounding communities in the Eengodi and Guinas constituencies which include the population of today's Nehale LyaMpingana constituency and which is a key area of the study; determines the existing socio-economic environment of the Oshikoto Region, evaluates

socio-economic issues relevant to the above mentioned proposed exploration areas according to the available literature and data; provides mitigation measures where applicable.

References consulted during the literature review are listed in Reference Section of this Report.

3 SOCIAL ENVIRONMENT

With a total land area of 38 653 km2, the Oshikoto Region occupies 4.69% of the country`s total land surface and is home close to 200 000 people, making 8.4% of Namibia's population.

The region's population has grown significantly over the past years, partly as a result of redistribution within the Oshiwambo-speaking area. Apart from Tsumeb and Oniipa, people have settled in a corridor along the trunk road, occasionally forming fairly dense concentrations.

The greater parts of the license area are general sparely populated considering that it is characterized by vast remote localities and cattle post areas.

3.1 POPULATION PROFILE – SIZE, STRUCTURE AND COMPOSITION

Most of the Oshikoto population is concentrated in the northwestern part of the Region while the license area is located in the eastern part of Oshikoto Region. The area of interest is populated with around 31 660 people, however this is together with the population of Eengodi constituency which is the most populated of all three affected constituencies (NSA, 2014a). Though the 2D seismic survey lines are touching a small area of the eastern part of Eengodi constituency (*Figure 1*) and where population is relatively small.

According to the 2011 Population and Housing Census data, Oshikoto Tables that are based on 4th Delimitation, and data of the Oshikoto Regional Council, the following is the population size of constituencies that are located in the area of interest (*Table 1).*

Table 1: Population size by area and density (Source of data: Oshikoto Regional Council, 2020; NSA, 2014a)

Constituency	**Population**	**Area in sq.km**
Guinas	5 460	4569.91
Eengodi	15 490	2107.77
Nehale LyaMpingana	10 710	9934.99

2011 Census and 2016 Inter-Census data revealed that female population is larger than male population in Oshikoto Region (NSA, 2014 and 2017a). In a period between 2011 and 2016, the female population shrunk from 52.2% to 51.8% and male population grew from 47.8% to 48.2%, thus the gender ratios are slightly balanced out.

The sex ratio of Oshikoto Region was 92 in 2011 and 93 in 2016. There are slight differences within the Region (*Figure 2)*. The sex ratios are higher in western constituencies than in eastern constituencies, meaning there are higher proportion of females to males in western constituencies than in eastern constituencies which are more balanced.

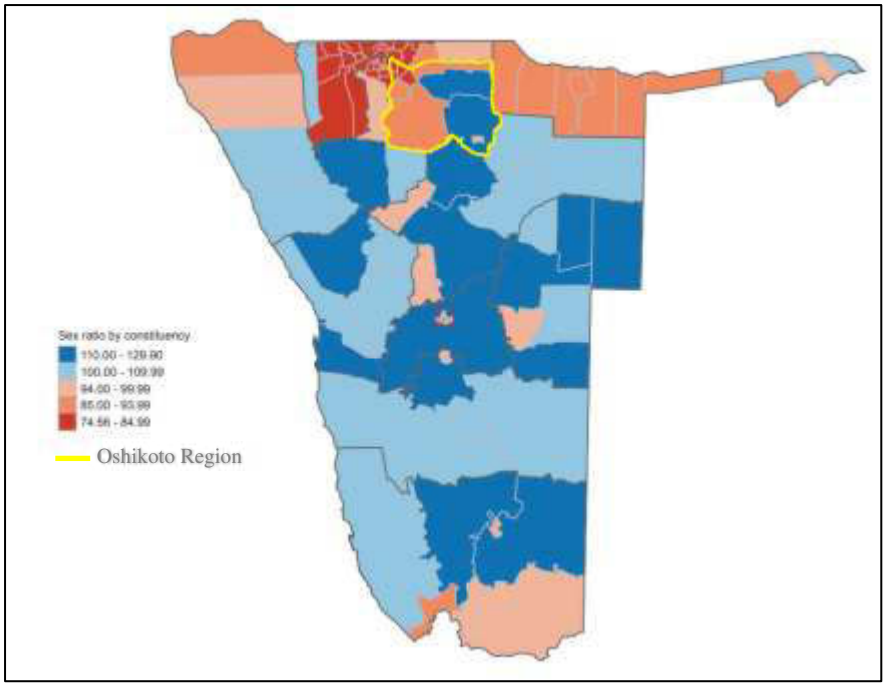

Figure 2: Sex Ratio of Total Population by Region and Constituency: 2011 (Source of data: NSA, 2014a)

At the constituency level, the population distribution by gender and area is as per *Table 2*. All three constituency have more males than females, particularly the area where most of the 2D seismic lines are traversing - Guinas and Nehale LyaMpingana constituencies (*Figure 3*).

Table 2: Population distribution by sex and area (NSA, 2014a)

Region	Constituency	Female	Percentage (%) of female	Male	Percentage (%) of male
Oshikoto	Guinas	2519	46.1	2941	53.9
	Nehale LyaMpingana	4558	42.6	6152	57.4
	Eengodi	7636	49.3	7854	50.7

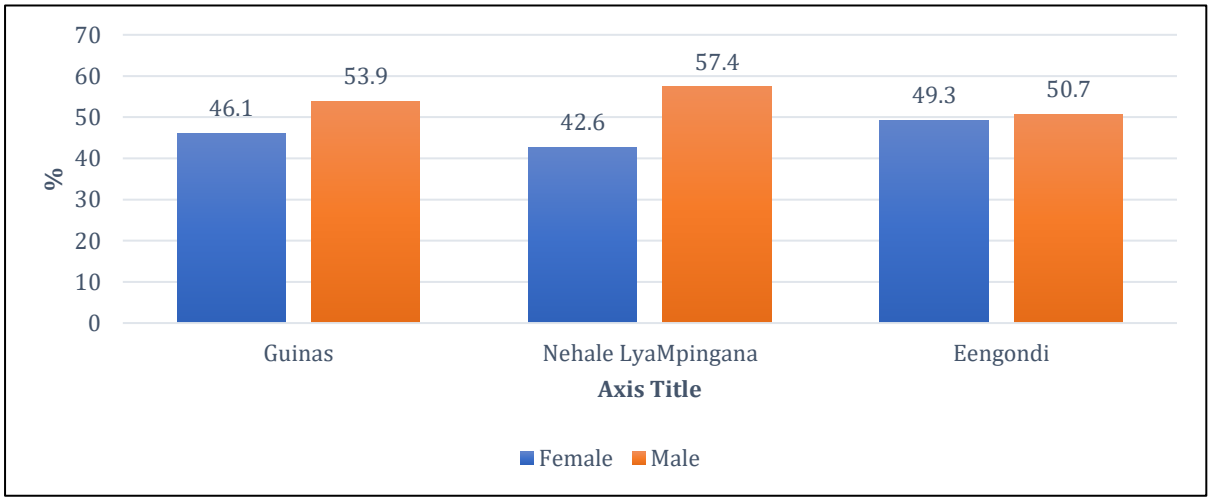

Figure 3: Percentage (%) distribution by gender and area (Source of data: NSA, 2014a)

The age distribution of the Oshikoto population by broad age groups and area is presented in *Figure 4*. The population pyramid in *Figure 4* has a broad base of young people and a narrow

apex with less old people, thus reflecting youthfulness of Oshana population. This shape of population pyramid is typical for population with high fertility and mortality rates.

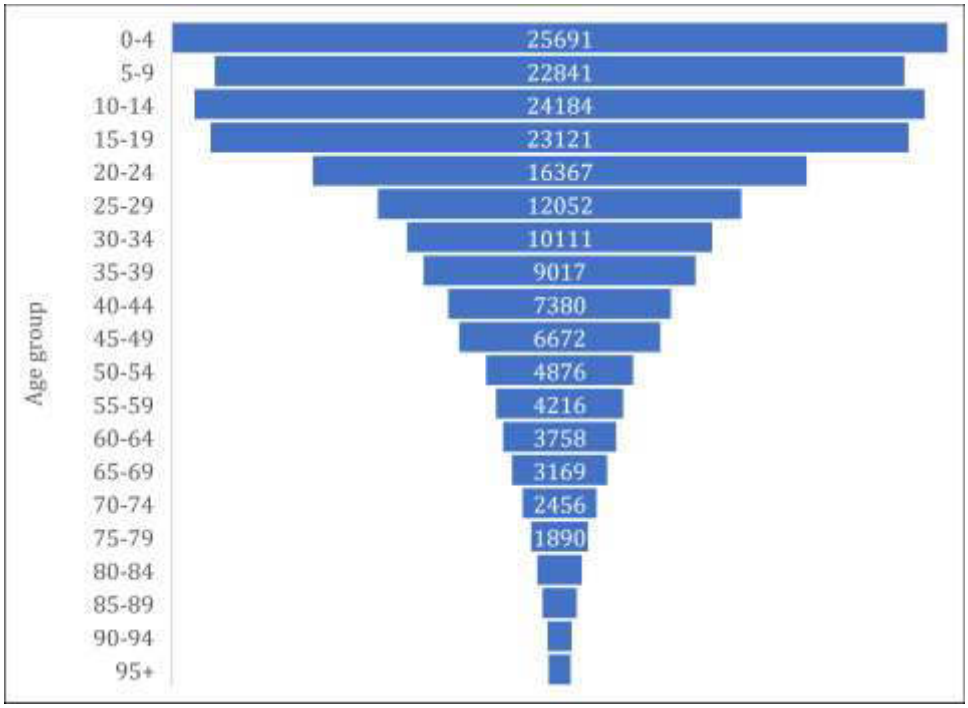

Figure 4: Distribution of the Oshikoto population by age (Source of data: NSA, 2014a)

At the constituency level Eengodi and Nehale LyaMpingana constituencies are more youthful than Guinas constituency. Guinas had highest percentage of working age population among the three constituencies (*Figure 5*) and which was above the average for Namibia (57.3%). Though the difference among the constituencies is not considerable. It could be explained that there were more employment opportunities in Guinas constituency than in other two constituencies. A large part of Guinas constituency is made up of commercial farms and few communal localities as for other two constituencies – Eengodi and Nehale LyaMpingana, they are made up of mainly communal farming.

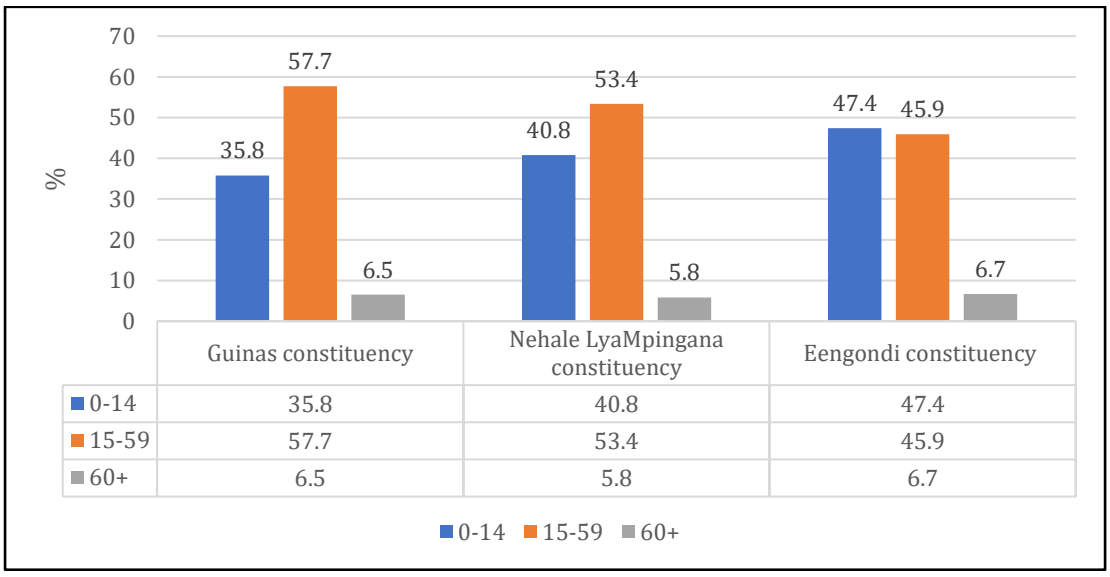

Figure 5: Distribution of population by age and area (Source of data: NSA, 2014a)

Approximately 62% of population aged 15 years and above in Oshikoto Region were never married, while 22.7% of the population were married with certificate. The statistical data also indicate that 5% of the population were in consensual unions and 4.4% were married traditionally (NSA,2012c).

The traditional marriages were more common in Nehale LyaMpingana and Eengodi constituencies which are more of typical rural constituencies than in Guinas constituency which is made up of commercial farms. Out of all marriages 11.3% in Nehale LyaMpingana constituency, 11.5% in Eengodi constituency were traditional marriage, contrary to 10.3% in Guinas constituency. Guinas constituency had a higher percentage of marriages with the certificate, making 21.4% of all marriages while Nehale LyaMpingana constituency had only 18.4% and 20.2% in Eengodi constituency (NSA, 2014a).

Guinas and Tsumeb constituencies had among the highest occurrence of the consensual unions in Oshikoto Region (*Figure 6*).

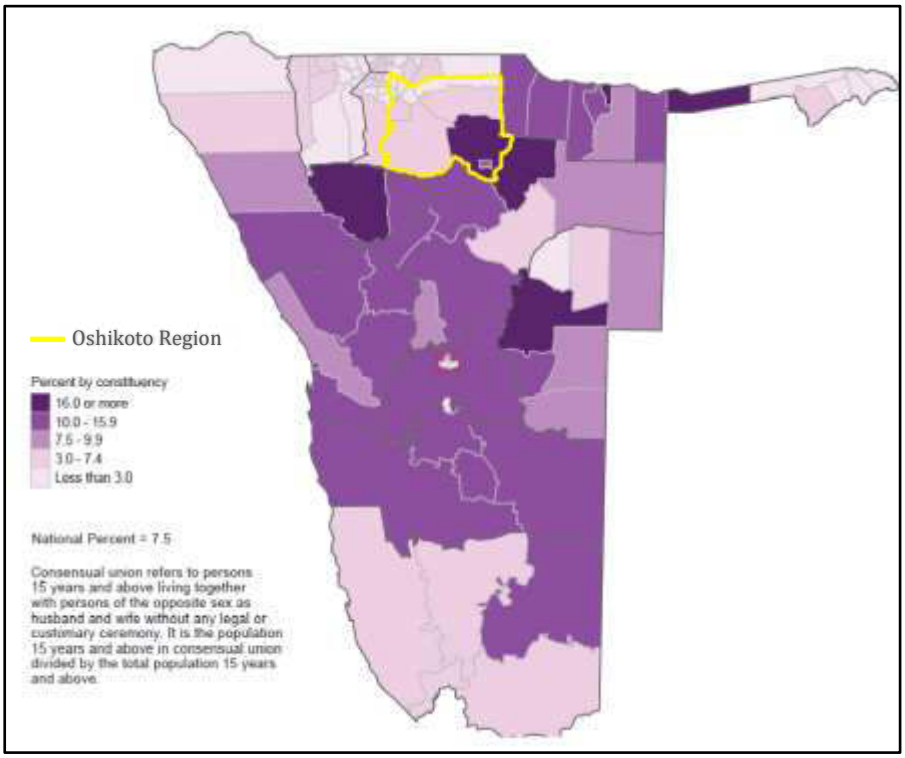

Figure 6: Percent of Population in Consensual Union by Constituency and Region: 2011 (Source of data: NSA, 2014a)

Analyzing gender distribution and marriages, there were more married males than females in Nehale LyaMpingana and Eengodi constituencies, and more married females in Guinas constituency. Equally the same trend was for never married people. There were more never married males in Nehale LyaMpingana and Eengodi constituencies, while Guinas constituency had more unmarried females (*Table 3*).

Table 3: Population aged 15+ years by marital status, sex and area (NSA, 2014a)

	Nehale LyaMpingana constituency			Eengodi constituency			Guinas constituency		
	Total	**Female**	**Male**	**Total**	**Female**	**Male**	**Total**	**Female**	**Male**
Total	6338	2524	3814	8150	4047	4103	6968	3891	3077
Never married	3789	1248	2541	4906	2169	2737	4207	2200	2007
Married with certificate	1167	542	625	1648	903	745	1491	870	621
Married Traditionally	719	359	360	936	504	432	718	416	302
Consensual union	404	202	202	281	156	125	186	97	89
Divorced	68	26	42	63	49	14	85	60	25
Widowed	140	118	22	241	217	24	217	201	16
Separated	42	27	15	66	42	24	59	44	15
Don't know	9	2	7	9	7	2	5	3	2

Oshikoto teenage pregnancy rate stands at 1.4% of all children ever born to females younger than 20 years of age. The female teens in age group 15-19 who has given a birth were more in Guinas and Nehale LyaMpingana Constituency, 2.64% and 1.81% accordingly. Around 0.2% of children were born in Nehale LyaMpingana Constituencyy and were born to girls in age group 12-15 years old (NSA, 2014a). Teenage pregnancies could have negative impact on the health of the adolescents and their infants. It also contributes to a higher level of poverty, illiteracy and a low level of education and thus a poor quality of life.

The 2011 Census data indicates that 6.7% of the total population of Oshikoto Region had disabilities. The proportion of people living with disabilities was higher in rural areas (6.9%) than in urban areas (5.4%). The physical impairment of lower limbs was the most common type of disability affecting about 24% of the population with disabilities. The next most common type of disabilities was visual impairment (15.4%) and mental disability (13.4%). Guinas constituency recorded the lowest rate - 5.2% of the population had disabilities (NSA, 2014a).

Mortality is one of the factors that affect the population size, age and sex distribution. *Figure 7* presents the number of reported deaths in the last 12 months by sex and area. The results show that a total of 240 deaths has occurred during the last 12 months prior to the survey in the area of affected communities – Guinas, Eengodi and Nehale LyaMpingana constituencies. Oshikoto Region reported 1866 deaths (NSA, 2017a).

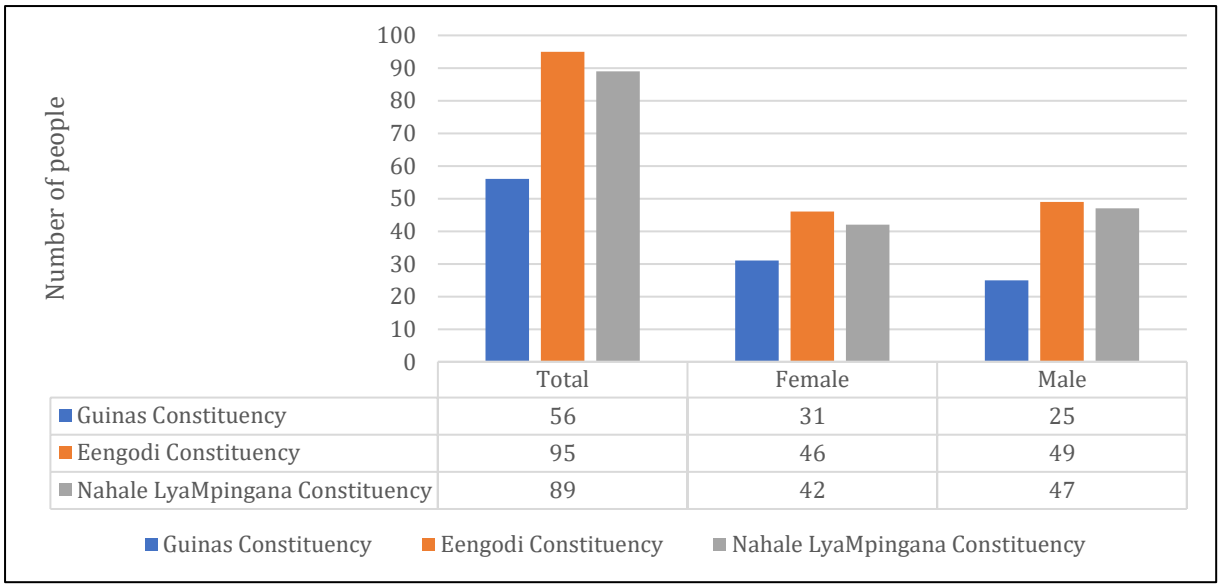

Figure 7: Number of reported deaths in the last 12 months by sex and area (Source of data: NSA, 2017a)

Eengodi and Nehale LyaMpingana constituencies stand out with higher female deaths, but Guinas constituency with higher male deaths (*Figure 7*).

For Namibia as a whole, the adjusted life expectancy at birth was 53.3 for males and 60.5 for females (56.9 for both sexes). At the regional level, in 2011 Oshikoto Region had life expectancy at 61.8 years for females and 52.2 years for males (NSA, 2014d), this is a considerable improvement in comparison to the earlier Census 2001 where female's life expectancy was only 49.8 years and 50 years for males.

Generally, the population of Oshikoto Region has been growing steadily, yet at a slightly slower paste than average for Namibia (*Figure 8*). In a period between 2001 and 2011 the annual growth rate for Oshikoto was 1.2% and then it slightly picked up to 1.4% in 2016 (NSA, 2017a).

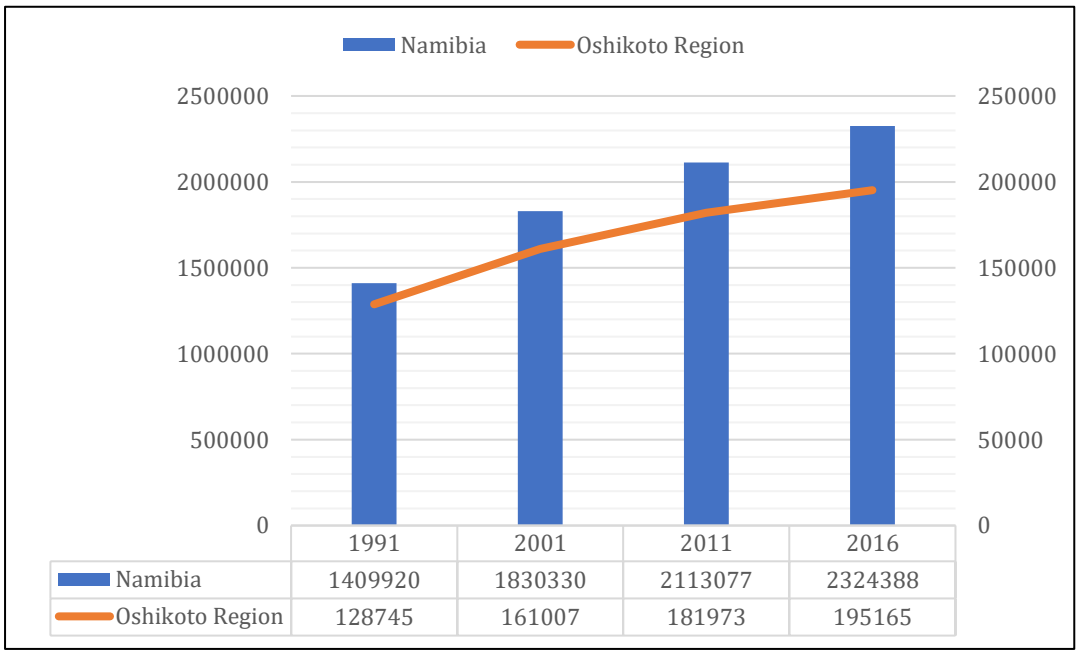

Figure 8: Population growth since 1991 to 2016 (NSA, 2012a, 2017a)

The projected population of Oshikoto Region for 2030 is 235153 people (NSA, 2012c) with 48.4% being male and 51.6% female population.

The area is sparsely populated in east, south and south east part (Etosha National Park) of the region and densely population in northwest part of region (*Figure 9*). However, it is the least densely populated region in comparison with the other three regions (Ohangwena, Oshana & Omusati) in the northern part of Namibia (NSA, 2011).

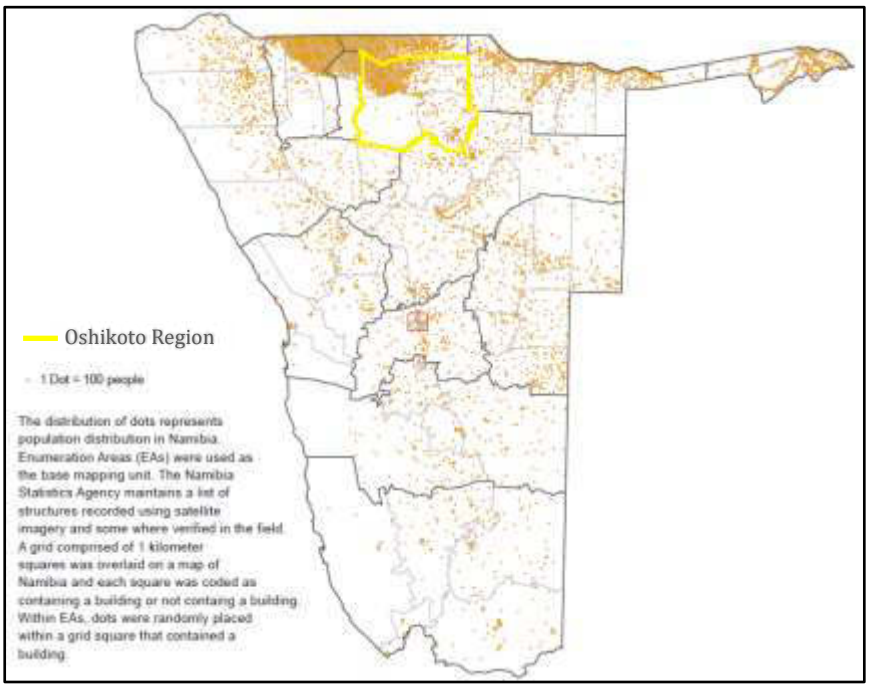

Figure 9: Population Distribution by Enumeration Area: 2011 (Source of data: NSA, 2014a)

Nehale LyaMpingana and Eengodi_constituencies are remote and typical rural constituencies of Oshikoto with a population of 10 710 people in Nehale LyaMpingana and 13 500 people in Eengodi constituency. The population densities are low characterized by vast remote localities and cattle post areas.

Guinas Constituency has a population of 5 460 people and large part of the constituency is made up of commercial farms. The settlement area of Oshivelo which was proclaimed in the year 1999 is part of the constituency.

Oshivelo, an Oshikwanyama name meaning ‘gate’ or ‘entrance’, is the gateway to the densely populated northern regions of Namibia (Olivier, 2020). To others it is a reminder of the contract labour system and the night curfew during the apartheid times in Namibia.

There was a noticeable movement of people from rural to urban areas. The long-term migration for Oshikoto Region was negative. There were more people leaving the area than coming in.

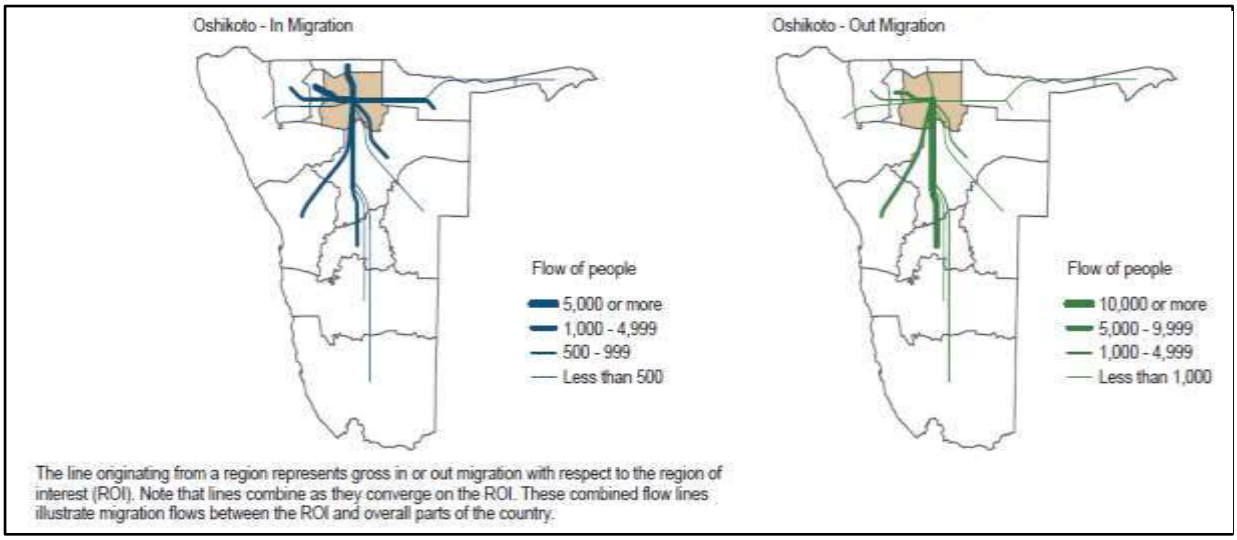

Figure 10: Long-term migration for Oshikoto Regions (Source of data: NSA, 2014e)

The main destination for outflow is Khomas Region, particularly Windhoek and Erongo Region (*Figure 10*). Likewise, there is a return flow from Khomas and Erongo Region to Oshikoto Region. Though the in migration from the nearby regions of Ohangwena, Kavango West, Otjozondjupa, Kunene and Oshana Regions is higher than outmigration to those regions.

3.2 SOCIO-ECONOMIC CHARACTERISTICS OF POPULATION

Important socio-economic characteristics in assessing the communities are their education, employment, source of income, household characteristics, household assets, access to services, housing and utilities, their health among the others.

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).

The literacy rates reported by the Oshikoto Regional tables based on 4th delimitation (2014) was 84%, with females scoring higher rate of 87% and males lower 81%. The literacy rates are high for population younger than 60 years, but noticeably declined for population older than 60, particularly for elder females (*Figure 11).*

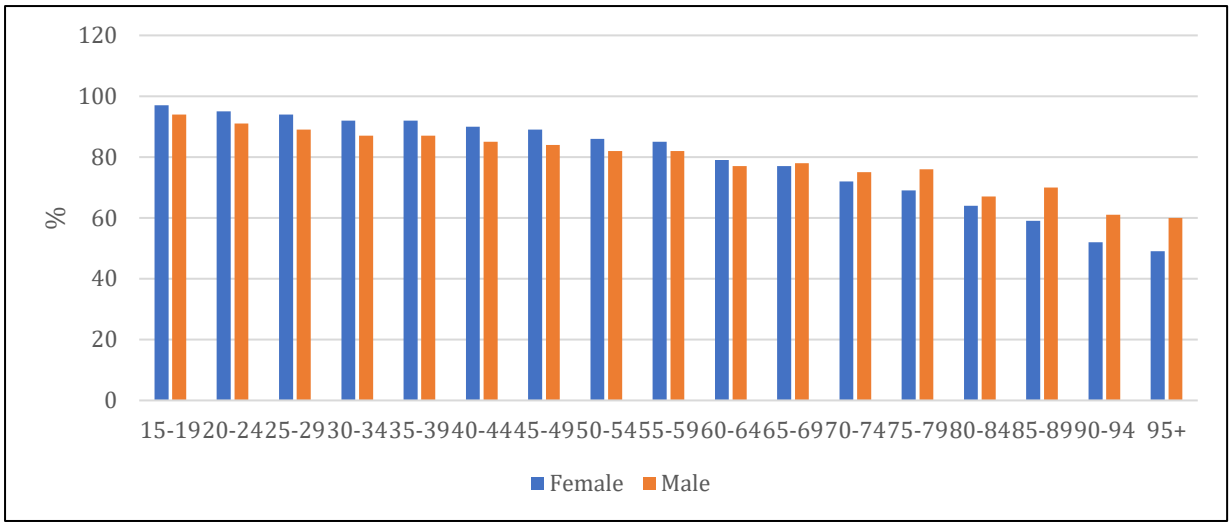

Figure 11: Literacy rate (%) for population 15 years and above by sex in Oshikoto Region (Source of data: NSA, 2014a)

Within the Oshikoto Region, the percent literate population aged 15 and above is higher in western and northern constituencies (*Figure 12*). The percent literate population in the area of interest is low for both, but particularly low is for female with the literacy rates less than 75%. Literacy rates in the project area, particularly for female, are among the lowest in the country.

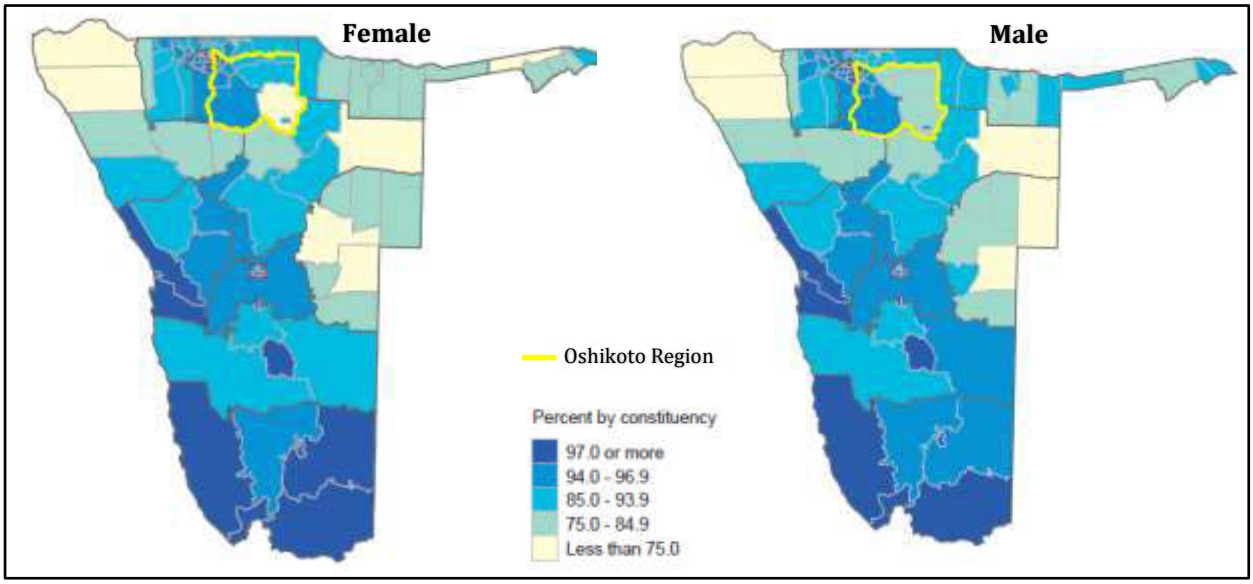

Figure 12: Percent literate population aged 15 and above sex and constituency: 2011 (Source of data: NSA, 2014a)

According to the NHIES 2015/2016 report there was a slight improvement. The results revealed that male literacy rate for Oshikoto Region was 84.3.3% and female literacy rate stood at 88.1%. 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 was 93.2% and for female (15-24 years) was 97.8%. This was above the average literacy rate for Namibia (94.4%) reported in NHIES 2015/2016 report.

Unfortunately, at the constituency level, the literacy rates are much lower than in Oshikoto Region. The adult literacy rate is presented in *Figure 13.*

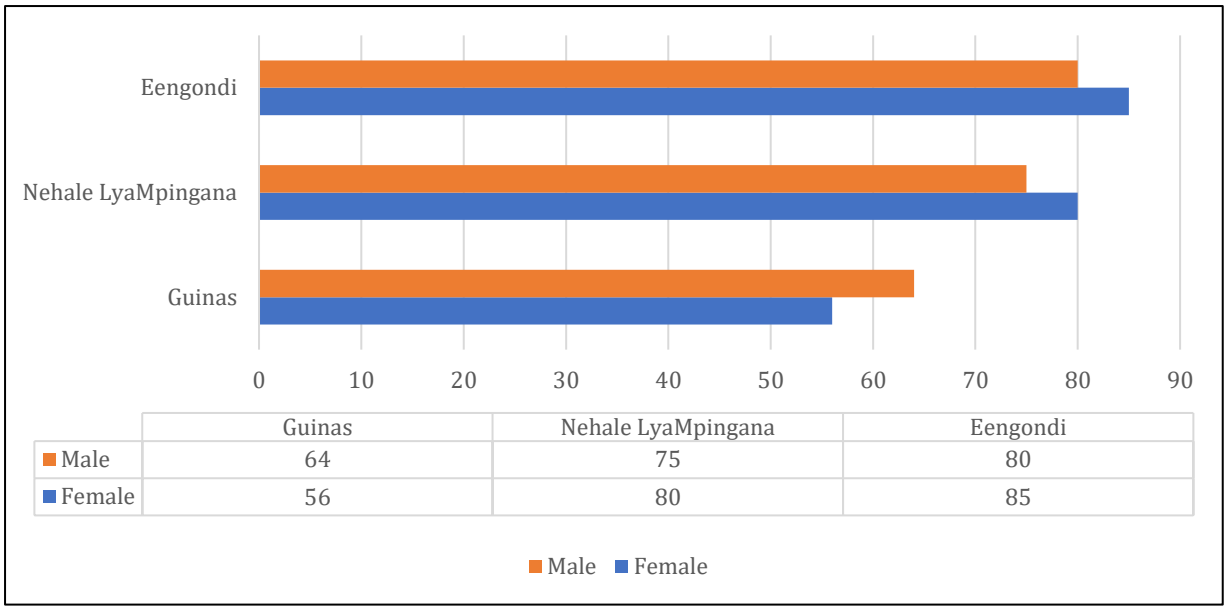

Figure 13: Literacy rate (%) for population 15 years and above by sex and constituency (%) (Source of data: NSA, 2014a)

All three constituency in the affected area had lower literacy rates than the rest of the Oshikoto Region. Particularly low literacy rates were in Guinas constituency where only 64% of males and 56% of females were literate.

School attendance for population aged 5+ by sex and area is presented in *Table 4*.

Table 4: School attendance for population aged 5+ by constituency and sex (Source of data: NSA, 2014a)

School attendance	**Total**	**Female**	**Male**
Nehale LyaMpingana constituency			
Total	8873	3665	5208
Never Attended	2338	858	1480
Pre-primary	149	78	71
Adult Educational Programme	170	76	94
Attending School	2043	953	1090
Left School	3745	1527	2218
Don't know	428	173	255
Eengodi constituency			
Total	12838	6292	6546
Never Attended	2613	1049	1564
Pre-primary	305	146	159
Adult Educational Programme	266	157	109
Attending School	4529	2270	2259
Left School	4643	2453	2190
Don't know	482	217	265
Guinas constituency			
Total	4262	1996	2266
Never Attended	1597	742	855
Pre-primary	99	62	37
Adult Educational Programme	32	19	13
Attending School	755	383	372
Left School	1652	725	927
Don't know	127	65	62

In total school attendance was lower among the females than males.

The data on regional unemployment rates in Namibia revealed that the Oshikoto Region's unemployment rate stood at 36.2% (NSA, 2019). Unemployment rate for Namibia was 33.4%

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. A lower unemployment rate signifies an economy having the capacity to absorb available people of working age, while a higher rate signifies an economy that is unable to absorb available people of working age. The unemployed comprise all persons of working age who were: a) without work during the reference period, i.e. were not in paid employment or self-employment; and b) currently available for work, i.e. were available for paid employment or self-employment during the reference period (NSA, 2017b).

Generally, the unemployment rate in Namibia was higher for females than males for all regions except four northern regions – Ohangwena, Oshana, Omusati and Oshikoto. Oshikoto Region has highest male unemployment (37.1%) among these four that are named above (NSA, 2019).

The large unemployment rate could 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. Oshikoto Region was among the Namibian regions that had high percentage of informal employment, 72.5% of persons had informal employment in Oshikoto Region (NSA, 2019).

The Labour Survey of 2018 results showed that youth unemployment rates were higher than the national youth unemployment rate (*Figure 14).*

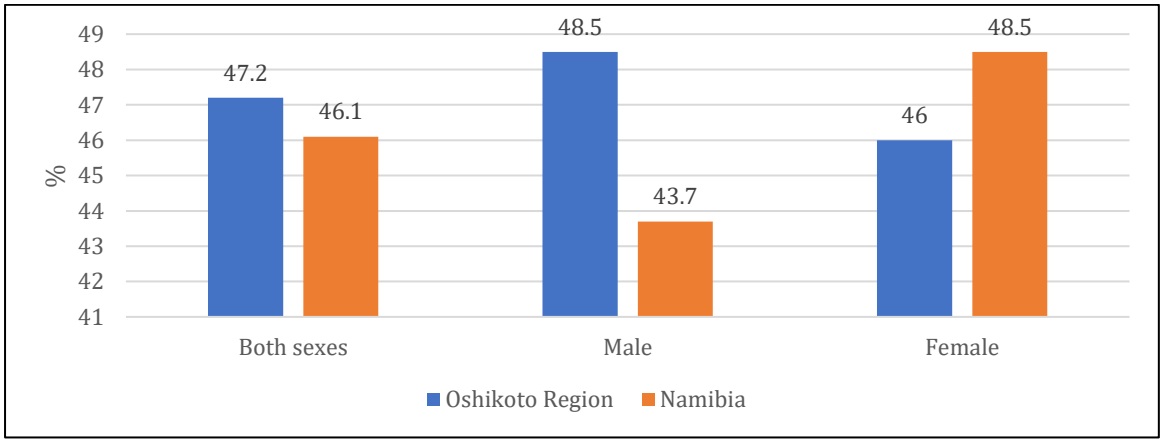

Figure 14: Unemployment rate for youth aged 15 to 34 years by area and sex Source of data: NSA, 2019)

While unemployment was generally higher for female youth than male youth in Namibia, the trend is opposite in Oshikoto region. Male youth unemployment is considerably higher than female youth unemployment (*Figure 14).*

The Namibia Labour Force Survey 2018 revealed that the youth unemployment rates of Namibia had deteriorated since earlier Labour Force Survey in 2016, yet Oshikoto Region slightly improved from 47.6% in 2016 to 47.2% in 2018. Though the unemployment dynamics was more favourable to female. While female youth unemployment dropped from 54.2% in 2016 to 46% in 2018, the male youth unemployment rate grew from 41.3% in 2016 to 48.5%

in 2018 (*Table 5*). That was a considerable shift in youth unemployment by gender in Oshikoto Region.

Table 5: Unemployment rate for youth aged 15 to 34 years by area and sex in 2016 and 2018 (Source of data: NSA, 2017b and 2019)

	2016			2018		
	Both sexes	**Male**	**Female**	**Both sexes**	**Male**	**Female**
Oshikoto	47.6%	41.3%	54.2%	47.2%	48.5%	46%
Namibia	43.4%	37.5%	49.4%	46.1%	43.7%	48.5%

The main occupations of the employed population is reflected in *Table 6*. Largest share of employed people worked as skilled agricultural and fisheries workers, in elementary occupations, service workers and craft and related trade workers. Nehale LyaMpingana Constituency has a significant number of employed who worked in armed forces.

Table 6: Main occupation of the employed population (in percentage) in Oshikoto Region and affected constituencies (Source of data: NSA, 2014a)

	Oshikoto Region	**Eengodi Constituency**	**Guinas Constituency**	**Nehale LyaMpingana Constituency**
Armed forces	731	22	19	226
Legislators, senior officers and managers	714	23	67	21
Professionals	2905	88	61	51
Technicians and associated professionals	1127	35	60	28
Clerks	1110	7	36	14
Service workers	3866	139	263	88
Skilled agricultural and fisheries workers	17187	1799	665	1571
Craft and related trade workers	3076	101	137	81
Plant and machine operators and assemblers	1144	26	42	51
Elementary occupations	4767	424	165	284
Don't know	11	1	1	0

The main employment industries in Oshikoto Region were farming, tourism and mining. As a main source of income for people in Oshikoto was farming 35.5%, followed by wages and salaries 25.3% and old-age pension 22.5%. Business activities, other than farming accounted for only 7.6% (*Figure 15).*

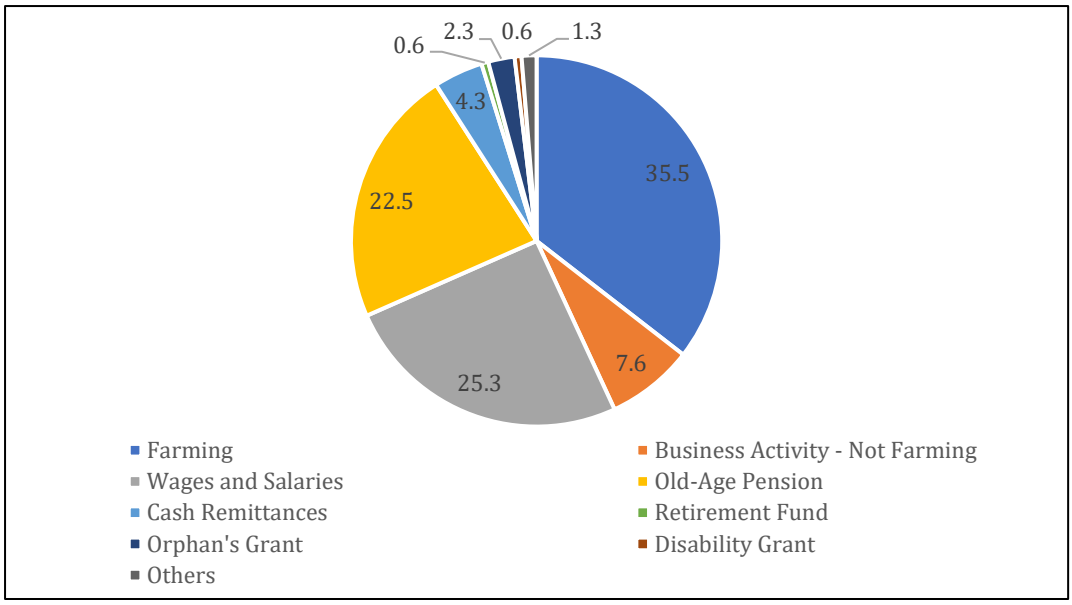

Figure 15: Population (%) by main source of income in Oshikoto (Source of data: NSA, 2014a)

In all constituencies farming constituted the main source of household income. The income from wages and salaries was larger in Guinas Constituency (64.9%), followed by significantly less in Nehale LyaMpingana Constituency (23.7%) and Eengodi (19.34) (NSA, 2014a).

Large share of people depended on the old-age pensions, cash remittances, retirement fund, orphan or disability grants, indicating dependency from income that was coming from social services or monies that were not generated by themselves, but provided by a relative or other person. Around 15% of Eengodi households, 13.5% Guinas households and 9.1% Eengodi households depended on old-age pensions (*Figure 16).* There was a significant percentage of Eengodi households that depended on orphan's grant, making 2.5% of all households in Eengodi constituency.

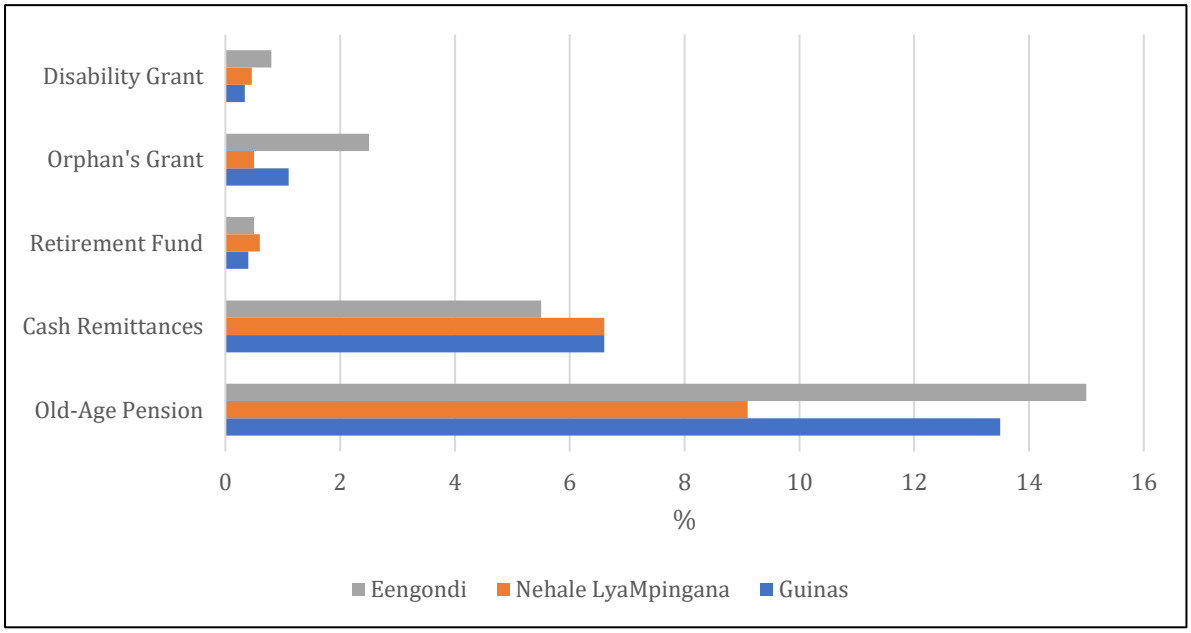

Figure 16: Households (%) dependent on pensions, remittances and grants (Source of data: NSA, 2014a)

In 2011, the incidence of poverty in the region was 43 % (77 520 people) and it represented a 15 percentage point reduction from the 2001 figure of 57 % (NPS, 2015). Though there was an improvement since 2001, Oshikoto was among the three poorest regions in Namibia (NSA, 2012d).

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 was considered to be "poor" when the annual per adult equivalent consumption is below the upper bound ("poor" – N$4535.52) poverty line. When the annual per adult equivalent consumption is below the lower bound ("severe poor" - N$3330.48) poverty line, an individual is considered to be "severely poor" (NPS, 2015).

Poverty in Namibia still bears a distinct rural face, with the poorest regions being those in which the majority of the population lives in rural areas. The poorest constituency in the region was Okankolo, with 63 % of the population classified as poor. It was followed by Eengodi (55 %) and Onyaanya (50 %). The least poor constituency was Tsumeb where an estimated 19 % of the population was classified as poor (NPS, 2015). Nevertheless, in 2011 all constituencies in Oshikoto Region had poverty incidence above the national average 27%.

Figure 17 shows that the poorest are people living in northern constituencies of Oshikoto Region. The poverty headcount rate in the area of interest was between 43.9% to 54.7%.

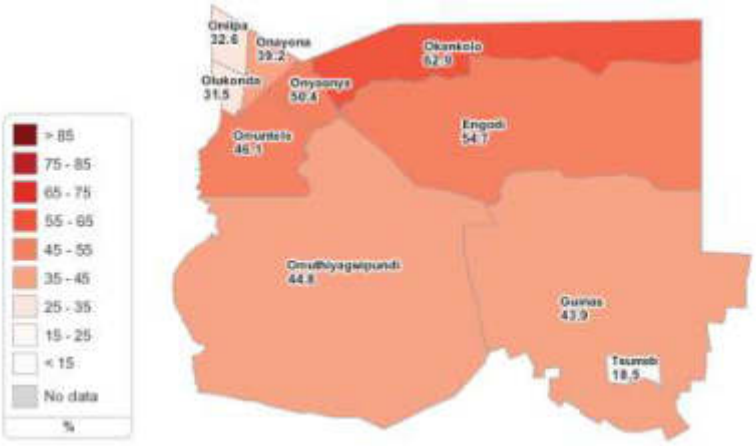

Figure 17: Oshikoto Regions Poverty Headcount Rate in 2011 (upper bound poverty line) (NPS, 2015)

Table 7 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).

Out of all listed assets in *Table 7*, the cell phone ownership was the most common as 93.9% of Oshikoto households had cell phone, 59.6% had a radio, 39.3% had a plough and 21.1% had a television. There were only 8.1% of households in Oshikoto Region that owned a motor vehicle, but access to a motor vehicle reported 24.9% households.

Table 7: Ownership of and access to assets (Source of data: NSA, 2017c)

		Selected Assets (%)											
		Motor vehicle	**Bicycle**	**Refrigerator**	**Freezer**	**Sewing / knitting machine**	**Radio**	**Telephone**	**Television**	**Cell phone**	**Donkey cart / Ox cart**	**Plough**	**Tractor**
Namibia	Owns	15.9	10.8	37.8	17.8	7.8	45.6	4.9	42.5	93.3	6.0	15.7	0.6
	Has access	30.9	10.0	10.3	18.9	11.0	23.7	9.1	11.8	2.5	9.1	11.3	16.2
	No access	53.2	79.3	51.9	63.3	81.2	30.7	86.0	45.7	4.2	84.9	73.1	83.2
Oshikoto Region	Owns	8.1	4.5	19.2	9.0	5.2	59.6	1.0	21.1	93.9	11.2	39.3	0.4
	Has access	24.9	6.9	11.8	26.0	5.4	20.2	7.7	10.9	2.4	15.6	14.3	37.3
	No access	67.0	88.7	69.0	65.0	89.4	30.2	91.2	68.0	3.7	73.2	46.3	62.3

Despite farming was named as a main source of income by a large proportion of households in affected constituencies (*Table 17*), the ownership of a tractor is among the lowest in the country. Only 0.4% households own a tractor. However, 37.3% of households reported of having an access to a tractor. Ownership of a plough was high (39.3%) in comparison to the national average of 15.7% households. Additionally, 14.3% of households had access to a plough.

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.

In 2016 Oshikoto household consisted of 4.3 persons on average which was a slight decrease from the average of 4.6 people in 2011 (NSA, 2017a).

In 2016 there were more female headed households in Oshikoto than male headed households (*Figure 18*).That is in a contrast to year 2011 when 51.4% of households were headed by males and 49.3% headed by females. Though the number of households increased. During the period 2011 and 2016, the increase was more than 8000 households, from 37400 households in 2011 to 45467 households in 2016 (NSA, 2017a).

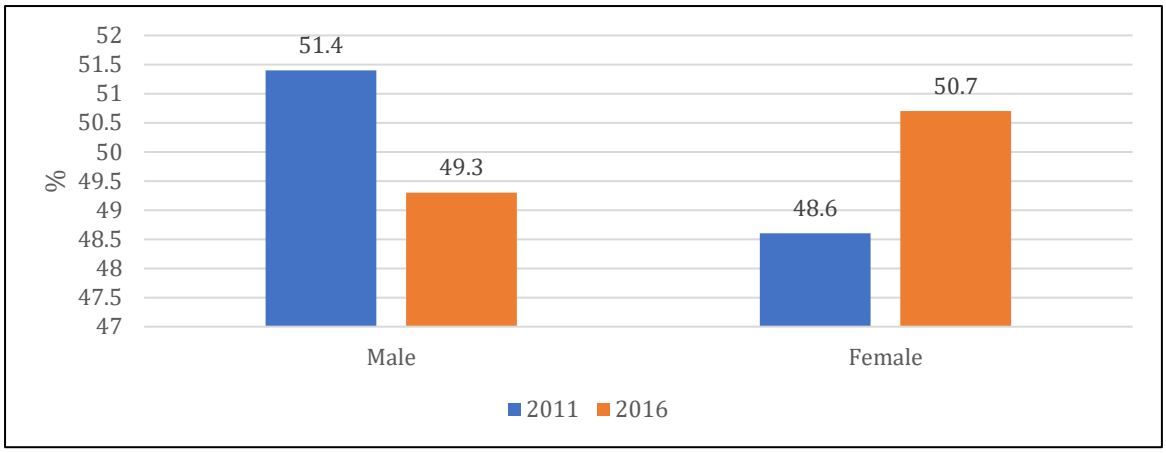

Figure 18: Percent distribution of household head by sex and year In Oshikoto Region (NSA, 2017a)

Sadly around 2% households were headed by children who were 18 years and younger. Oshikoto Region has one of the highest number of households headed by children and only Ohangwena has slightly more (2.4%). Average for Namibia is 1.2% of households that were headed by children in 2016. Furthermore 0.7% of households were headed by orphaned children. In total those were 307 households in Oshikoto Region (NSA, 2017a).

The 2011 Census data indicated that traditional dwellings were the most common type of housing unit, making up 69.7 percent of all households in Oshikoto Region. These were followed by detached houses (14.2%) and semidetached houses (6.1%). Improvised housing units/shacks constituted 4.8% of all households in 2011 (NSA, 2014a). Traditional houses were most common in rural areas, but Guinas constituency, where commercial farms prevail, only 22.1% of all housing were traditional dwellings. By contrast, Guinas constituency had 15.4% improvised housing units/shacks, highest concentration of shacks in the Oshikoto Region. Around 4.8% of housing were improvised units/shacks (NSA, 2014a).

The Inter-Census Survey in 2016 revealed that the most common housing in the area of interest was still a traditional dwelling (60.3%), but since 2011 (*Table 8*) the improvised housing units (shacks) in Oshikoto Region increased from 4.8% in 2011 to 10.5% in 2016 (NSA, 2014a and 2017a).

Table 8: Percent distribution of households by type of housing unit and area in 2016 (Source of data: NSA, 2017a)

	Detached house/ Semi-detached	**Apartment /Flat**	**Single quarters**	**Traditional dwelling**	**Improvised housing unit (Shack)**	**Other**
Namibia	30.8	6.1	2.4	32.6	26.6	1.4
Oshikoto	19.6	6.9	0.5	60.3	10.5	2.3

The average number of persons per sleeping room (or room occupancy) was derived from the number of sleeping rooms in a household by the household population. In 2016 Oshikoto households had 1.3 people per room which is in line with average number of persons per sleeping room in Namibia (1.5). This indicator measures crowding in a household. For health purposes, international standards requires that a standard room be occupied by one person or at most by two persons (NSA, 2017a).

Household's main source of energy for cooking was fire wood. In 2016 Oshikoto Region had 70.9% of all households using fire wood for cooking. Electricity from mains was used by only 18.8% of households in Oshikoto Region (NSA, 2017a).

With respect to the source of energy for lighting, the 56.6% of Oshikoto households used battery lamps, torches and cell phones, 30.8% of households used electricity /generator. The usage of candles for lighting had decreased to 5.8% in 2016 (NSA, 2017a).

93% of households had safe drinking water, with 30.3 % of the households having access to piped water inside the house and 38.2% of households having piped water outside. Similarly,19.9% of households get drinking water from public pipes. However, 0.6% of households draw their drinking water from rivers and dams (NSA, 2017a).

3.3 MARGINALISED/DISADVANTAGED SAN COMMUNITIES

San people are one of the oldest ethnic group found in Namibia. They were known as the first people to occupy the territory of present Namibia. The San number between 28 000 and 35 000 and they represent slightly more than 1% of the national population. They include the Khwe, the Hai//om, the Ju|'hoansi (and related ǂKao||'aesi), the !Xun (comprising of four or more distinct populations), the Naro and the !Xóõ (and related N|oha) (IWGIA, n.d.).

Despite being scattered among other ethnic groups and rarely forming the majority, the San had preserved a strong sense of cultural and ethnic identity. Each of the San groups speaks its own language and has distinct customs, traditions and histories .
Historically, the San were mainly hunter-gatherers in the past but, today, many have diversified livelihoods. Over 80% of the San have been dispossessed of their ancestral lands and resources, and they are now some of the poorest and most marginalised people in the country.

Therefore, it requires a particular attention to look into their socio-economic well-being withing the area of proposed 2D seismic surveys.
Oshikoto Region has traditionally been occupied by San groups, mainly Hai||om and with a smaller proportion of !Xun – living mostly in the freehold areas, with just a few groups living in the communal areas (Dieckmann, 2014).

The Hai//om are the largest San population in Namibia, numbering some 15,000 people, and they are some of the most widely distributed San people in the country. The history of the Hai//om has been one where they experienced being removed from their ancestral lands through such processes as the creation of commercial farms, the enlisting of labourers for farm and other work, the establishment of colonial police posts, and the declaration of the game reserves in the early part of the twentieth century (Hitchcock, 2013; Dieckman 2007). Most of the Hai//om who lost their lands ended up working on commercial farms while some were retained as trackers, scouts and labourers by the Department of Nature Conservation in the game reserves.

Hai//om had used Etosha as a sanctuary. They entered the area to avoid Administration and police patrols. In the Game Reserve, their presence was tolerated by the Germans until the end of their colonial domination in 1915, and by South Africa personnel until the 1950s. The Hai//om were allowed to hunt and gather in the reserve and to possess bows and arrows and other hunting weapons.

According the paper prepared by Robert Hitchcock (2013) on the Hai//om people of Namibia, Etosha and resettlement in 1949, the South West African administration appointed two-person Commission for the Preservation of the Sun (Bushmen). It was chaired by a former Stellenbosch University professor, P.J. Schoeman, who had become the Chief Game Warden in Etosha, South West Africa's most significant protected area. Schoeman, through his writings, helped to popularize stereotypes of San as pristine hunter-gatherers and as people capable of surviving in marginal environments (Hitchcock, 2013).

In 1951 Schoeman and the Commission for the Preservation of the Sun (Bushmen) produced an interim report in which two "Bushmen" reserves were recommended: one for Khaung (!Kung) and another for the "Heikom" (Hai//om) people. However, when the final report came out in 1953, there was only one Bushman reserve recommended, that of "Bushmanland" which was where the Ju/'hoansi lived (now Tsumkwe District in Otjozondjupa Region). Despite the Hai//om were the largest San population in the country, were not to be given a reserve (Hitchcock, 2013). The reasons for that were related to the labour needs of commercial farmers and to the fears of some people in Nature Conservation that Hai//om could have a significant impact on the wildlife populations in the reserve. Hitchcock, 2013).

In the 1950s the Department of Nature Conservation decided to move the estimated 400 to 500 Hai//om living in the bush in the park to places outside the reserve. However according to Hitchcock (2013), the oral history evidence suggested that Hai//om who were not workers or their families continued to visit the park quietly after their removals from the park in the mid-1950s up to recent times. They went in to the park to see relatives, to collect wild resources, to visit sacred sites, and go to the graves of relatives and friends.

After Independence many Hai//om farmworkers were dismissed and moved to towns or newly established resettlement farms, such as Tsintsabis (Dieckmann, 2014).

Unlike some other Namibian San such as the Khwe, the Hai//om have not yet gone to court in an effort to obtain land and resource rights. They have, however, engaged in direct action in order to raise public awareness about the situations that they faced (Hitchcock, 2013). In January, 1997 Hai//om demonstrators blocked the entrances to two gates into Etosha National Park and 73 people were arrested. This incident brought international attention to the issue of Hai//om land rights. This land struggle is part of the Hai//om identity revitalization that is on-going until now (Hitchcock, 2013).

There are several GRN farms in Oshikoto Region where Hai//om have been resettled – some of them located south of Etosha National Park, Tsintsabis, Farm Six and at Oshivelo.

Oshivelo is located in the proximity to the proposed 2D seismic survey lines (*Figure 1).* According to Dieckmann (2014) fieldwork, most of Oshivelo's inhabitants were Hai//om, and there were also Khwe and people from Zambezi, Kavango Regions as well as Owambo people and few Zimbabweans living there. It was estimated approximately 2700 Hai//om in about 300 households living in Oshivelo.

Most of Hai//om were living in the southern part of the settlement – an area known as the 'cemetery location' due to its close proximity to the cemetery. Their houses were made of corrugated-iron and plastic sheeting, and there were no water or electricity in the "cemetery location' houses. There were three water points and Hai//om did not have to pay for using this water as the councilor's office paid the NamWater bill. The water points were located about

100m away from the houses. As there was no electricity supply to the Hai//om houses, the location was referred to as *Donkerhoek* (‘dark corner’) (Dieckmann, 2014).

In the northern location of Oshivelo Hai//om owned a few of the brick houses which were built with support from the Build Together program. These houses had running water and electricity. To pay the water bills was the responsibility of residents and not many could afford. As a result the water supply in a few of the Hai//om houses had been cut off due to the household’s inability to pay the bills. The employment rate among Oshivelo’s Hai//om was very low (Dieckmann, 2014).

There was a clinic at Oshivelo and a combined school for Grades 0 to 10 which was located 3km from the ‘cemetery location’ of the Hai//om community. There was a police post and a veterinary office. In Oshivelo at least 4 churches were active. According to Dieckmann’s (2014) fieldwork findings there were around 50 shebeens, small shops, a fuel station and a kindergarten at the settlement. Other employment opportunities were scarce. Dieckmann (2014) reported on various projects for Hai//om that has been initiated and supported by both Government and the NGOs. The Oshikoto Regional council initiated and supported two projects: a coffin-making project and a bread-baking project, but they did not last long. The Hai//om at Oshivelo had also received support from WIMSA.

The few notes in the Oshikoto Regional Poverty Profile of NPC (2007) and 2011 Census data (NSA, 2012a) suggested on the situation of the San communities living among Owambo communities in the communal area of Oshikoto Region. The census indicated that 1.6% of the population spoke a San language at home. Dieckmann (2014) believed the actual number of Hai//om speakers could be higher because of the similarity of the Hai//om language and Nama/Damara, suggesting that a number of people reported Nama/Damara as their home language instead of Hai//om.

In 2012 the government acquired a resettlement farm Ondera that was a combination of two farms - Ondera and Komeva. The farm is situated 20 km east of Oshivelo and about 70km north of Tsumeb, which is within the area of the proposed 2D seismic survey lines.

The farm Ondera was acquired for the resettlement of disadvantaged communities. In 2012 the Hai//Om San community living at Oshivelo had welcomed the government decision to resettle them at Farm Ondera (Shivute, 2013). By 2013 some 130 households from Oshivelo were resettled to Ondera. On average, each household here had around five members. In 2018 Ondera had already 500 households and it had garden and about 252 heads of cattle.

One of the major success stories at the time was the community gardening project, which was divided into 11 hectares for crop cultivation, while eight hectares were reserved for vegetable production. On the smaller portion of land, the community grew beans, tubers, tomatoes and other vegetables. The produce was for the community's benefit, for subsistence use, and to consume at household level. Every week, a car full of produce was driven from Ondera to Oshivelo, Tsumeb and even to Grootfontein to sale their harvest. In 2015, the community sold 50 bags of maize for N$71 000 (Mumbuu, 2018).

However, despite an array of positive stories from Farm Ondera, there are shortcomings too. In 2021 it was reported that the once flourishing government resettlement farm of Ondera had turned into a shadow of itself. Agricultural production had come to a halt because of the inability of the occupants to pay electricity bill (Simasiku, 2021). Lack of water was a set back

for the farming activities as the community struggled to provide water for their household use. Ondera's farming project has not produced anything in last years and there was no other activity generating income. The poverty had set in. Another drawback identified by the community was the human wildlife conflicts (Mumbuu, 2018).

Before the relocations Ondera did not have a school, but today the community has a school that goes up to Grade 4 and children do not have to travel to Oshivelo or Ombili (a nearby farm) to attend school. While acknowledging efforts towards the betterment of Ondera, the school's principal sited the numerous challenges they face, especially conflict with wildlife. Lions and leopards from the Etosha National Park frequently visited the farm due to broken fences - the result of a wildfire. That is not safe for children walking to school (Mumbuu, 2018). In 2019, the MVA (Motor Vehicle Accident Fund) as part of its Corporate Social Responsibility bought fencing material for Ondera Primary School and every learner received a pair of shoes, a pair of socks and a jersey (Rasmeni, 2019). While this contributed positively to the lives of the community there are still plenty needs to satisfy.

Another predicament for Ondera's residents was that there were no permanent health facilities and the community relied on health extension workers.

Land grabbing and crime was a challenge, as members of neighbouring villages allocated land on the farm at their own discretion, on the grounds that it was purchased by the government (Mumbuu, 2018). There was a growing dissatisfaction with the collective resettlement of San people on farms, while other Namibians were resettled as individuals. The questions raised were – why the marginalized groups such as San were being grouped, instead giving an individual allotment? (Mumbuu, 2018).

The San are among the poorest people in Oshikoto Region, but it has to be noted there are many very poor people among other ethnic groups too (NPC, 2007).
In 2007 Namibia voted in favour of the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), but has not ratified ILO Convention 169, an international legal instrument that specifically addresses the rights of Indigenous Peoples.

Namibia is a signatory to several other binding international agreements that affirm the norms represented in UNDRIP, such as the African Charter on Human and People's Rights (ACHPR), the Convention on the Rights of the Child (CRC), the International Convention on the Elimination of all forms of racial discrimination (ICERD) and the International Covenant on Civil and Political Rights (ICCPR) (IWGIA, n.d.).

4 SOCIAL INFRASTRUCTURE AND SERVICES

The vital element in the quality of life is the quality of and reasonable access to infrastructure and services.

Education services
Access to education and health facilities form part of the vital key aspects that contribute to development of the region.

According to the *2019 15th School Day Statistics* there was a combined total of 221 schools in Oshikoto Region ranging from Grades 0 up to Grade 12, with 94 primary schools, 93 combined schools, 18 secondary school and 16 junior primary school (Oshikoto Regional Council, 2020).

Oniipa Constituency had the highest number of schools taking up 13% of the whole region. There were a total of 30 schools, where 13 were combined schools, 11 primary schools, 3 junior primary schools and 3 secondary schools. Onyaanya Constituency recorded the second highest with total of 28 schools (13%), 12 primary school, 11 combined schools, 3 junior primary schools and 2 secondary schools. These are constituencies with the highest population densities in Oshikoto Region (Oshikoto Regional Council, 2020).

The project area - Eengodi, Guinas and Nehale LyaMpingana Constituencies had recorded no secondary school (Grade 8-12). GuinasConstituency had only 6 schools of which 5 primary schools and 1 combined school (Oshikoto Regional Council, 2020).

According to the Regional council information, the majority of permanent classrooms (49%) in Oshikoto Region were built as prefabricated, 10% were built by clay bricks and 10% as sheds.

At the constituency level, Oniipa Constituency had 397 permanent classrooms, which was the highest number in Oshikoto Region. The least number of permanent classrooms were recorded in Guinas Constituency with only 57 permanent classrooms (Oshikoto Regional Council, 2020).

The Regional council information indicated that there was a shortage of classrooms of 426 and 39 (18%) classrooms were under construction. There was a total of 53 libraries, 53 laboratories and 65 admin buildings in Oshikoto Region (Oshikoto Regional Council, 2020).

The highest number of temporary classrooms was recorded in Eengodi Constituency with a total of 91, followed by Okankolo with 68 and the least number of temporary classrooms was recorded in Olukonda with only 2 and 1 in Guinas. There were no temporary classrooms in Tsumeb Constituency.

Eengodi Constituency ranked number one when it comes to classrooms shortage with a total of 83 and 12 classrooms were under construction. Omuthiyagwiipundi ranked the second highest in terms of classroom shortage with 71 but recorded no classroom under construction (Oshikoto Regional Council, 2020).

Among the challenges reported by the Oshikoto Regional Council (2020), they were i) limited budgetary allocation, ii) insufficient boarding facilities, iii) long distances between schools, iv) high repetition rate of 17.7% and v) the regional office was still operating at Ondangwa while the Regional Council is at Omuthiya (±85 km).

Adult education was offered throughout the whole region and supervised by eleven (11) District Education officers. The Namibia University of Science and Technology through its Centre for Open and Lifelong Learning (COLL) offered distance education study programmes to out of school youth and working adults who were not able to attend classes on a full-time/part-time basis at the Main Campus in Windhoek. The students accomplished their studies through the distance education mode: both in print and online, providing a rich learning environment in a flexible and interactive manner. The Tsumeb Regional Centre opened in January 2009 to provide access to higher education to out of school youth and working adults in the Oshikoto Region and some parts of the Otjozondjupa Region.

Health services

According to the Oshikoto Regional Health Directorate there were 3 district hospitals – Tsumeb, Omuthia and Onandjokwe, 3 health centres and 22 primary health care clinics. These were public health institutions and were accessible to all Namibians. Apart of the public health services, there were a number of private health services, including a private hospital in Tsumeb.

Tsumeb private hospital was a remnant of the previous mining company that operated in Tsumeb. Initially, the hospital was established to specifically provide services to the employees of the mine and their families and now it is open to anyone who can pay for services. Some of the modern health care facilities at the hospital were: 40 bed facilities, two theatres, one recovery room, a maternity ward, rehab facility, inhouse pharmacy, fully operational health clinic, 3rd party lab, path care lab, X- Ray facilities, and a casualty ward.

At the constituency level of the project area, there were following public health facilities: Onamishu Clinic in Eengodi Constituency, Oshivelo and Tsinsabis clinics at Guinas Constituency and Hedimbi and Elavi clinics at Nehale LyaMpingana Constituency (Oshikoto Regional Council, 2020).

In terms of communities' health, during the period of 2016 and 2017, Oshikoto recorded lowest percentage distribution for tuberculosis related death in the country (below2%), among the lowest percentage distribution for malaria related deaths (below 5%) and neonatal mortality rates (deaths in new-born aged less than 28 days) per 1,000 live births (NSA, 2020).

Most common causes of hospitalization were – spontaneous delivery/normal vaginal delivery 2 761 cases in a period March to September 2015, followed by diarrhea gastroenteritis between 820 cases, 502 cases of caesarian section, 339 cases of pneumonia,283 cases of spontaneous abortions and others in smaller numbers (NSA, 2015b).

The HIC prevalence rate stood at 7.7% for all ages (2012) and 19.5% (2010). Moderate malnutrition was at 4% and severe at 0.5% (Oshikoto Regional Council, 2020).

Police stations

There were 15 functional police stations and 5 non-functional police stations in Oshikoto Region (Oshikoto Regional Council, 2020) (*Figure 19).*

Functional police stations	Non-functional police stations
Tsumeb "A" class police station	Onkumbula "C" class police station
Nomtsoub "C" class police station	Oshigambo "C" class police station
Oshivelo "B" class police station	Onethindi "C" class police station
Tsintsabis "C" class police station	King Kauluma "C" class police station
Bravo "C" class police station	Emanya "C" class police station
King Nehale Gate "C" class police station	
Omuthiya "A" class police station	
Onathinge "C" class police station	
Onankali "C" class police station	
Onyuulaye "C" class police station	
Okankolo "C" class police station	
Onayena "C" class police station	
Okatope "B" class police station	
Omuntele "C" class police station	
Onanke "C" class police station	

Figure 19: List of police stations in Oshikoto Region (Source of data: Oshikoto Regional Council, 2020)

The most prevalent crime cases that were reported in Oshikoto included theft, GBV, rape, stock theft, house burglary, reckless and negligent driving, road accident, culpable homicide, murder and malicious damage to property. Tsumeb magistrate court was the only court in the region and traditional authority had customary courts.

The crime cases had considerably increased during the period of 2014/15 – 2018/19 year, particularly in year 2017/2018 (*Figure 20*), but dropped in year 2018/2019. Oshikoto Regional Council (2020) had identified main developmental challenges and the lack of police vehicles that were compatible to travel in a rough terrain and networking was among the challenges.

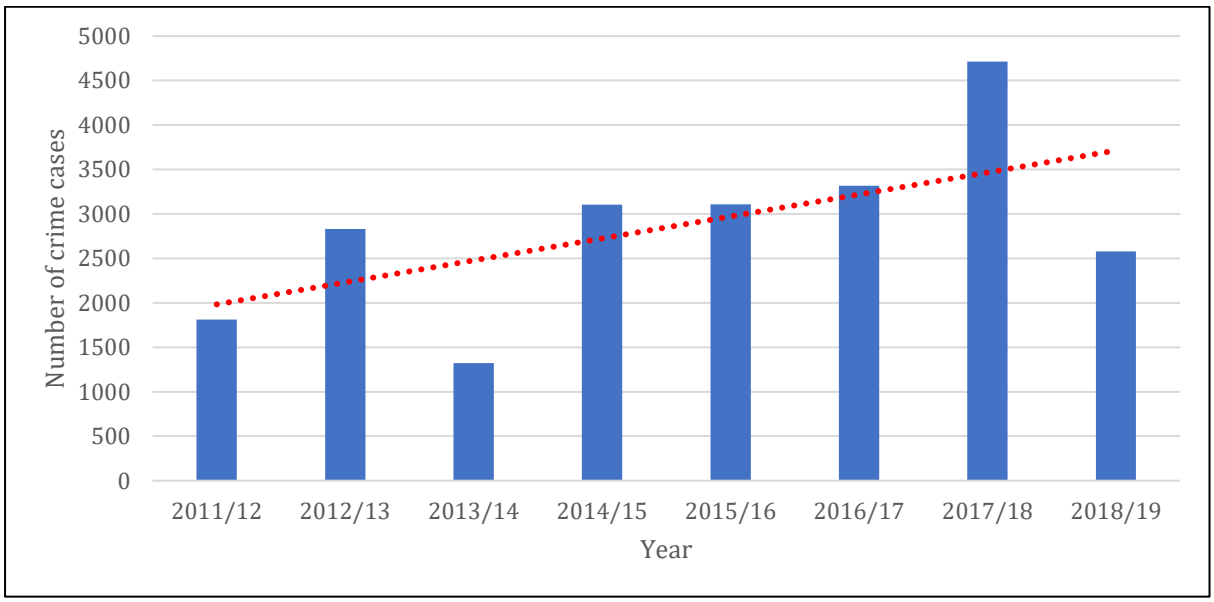

Figure 20: Total number of crime cases in the period 2011/2012 to 2028/2019 year (Source of data: Oshikoto Regional Council, 2020)

Roads, railway and airports
Oshikoto Region is traversed by the the B1 trunk road (272 km) that connects with southern and northern Namibia. Acording to the Oshikoto Regional Council, a feasibility study was conducted to upgrade the B1 main road between Omuthiya and Ondangwa to a dual carriage road whereas the Tsumeb railway extension is linking the region to Angola (Oshikoto Regional Council, 2020). The updated road network will make it possible for inhabitants of the Oshikoto Region to trade and communicate with other people in neighboring regions.

Other roads are linking urban centers with rural centers and other growth points.
Roads network between centers, growth points as well as other regions promote and stimulate economic growth in the region in particular and county in general.

The upgraded road of the Onayena - Okankolo bitumen standards will immensely benefit the community and spur economic activities. Also the upgraded road for Oshigambo- Eenhana is promoting economic and social activities between Oshikoto and Ohangwena region. Another road is planned to connect Omuthiya and Onamishu, which will open access between Onkoloti and Okashana-Koomanya. Other roads are linking up urban centers with rural centers and other growth points.

The communities living along those tarred and gravel roads now have access to a reliable road, which enables them to reach their destination safely and with more ease.

The establishment of the Tsumeb-Katwitwi road has opened up another trade and communication corridor as it links the Oshikoto Region industrial hub with Katwitwi border settlement and by extension the capital city Menongue in the Kuandu Kubango province of Angola. This direct link between Tsumeb and Angola creates business and trade opportunities between the two countries in the various sectors of the economy such as mining, tourism, logistics notwithstanding agriculture (Oshikoto Regional Council, 2020).
The larger part of the Oshikoto Region is being served by undeveloped roads, while road access to other localities is through sandy tracks which can only be accessed by 4x 4 vehicles.

Tsumeb has an air strip that is not operation at present. Municipality has since resolved to allow construction of the new internal Airport through the Smart City Project (Oshikoto Regional Council, 2020).

Mokuti and Oshivelo Air Fields provide travellers with air services which are essential to land them at destinations of their choices. Tourists, business people as well as captains of various industries utilize such services to reach their destinations timely.

According to the Oshikoto Regional Council (2020), the extension of the Tsumeb - Ondangwa - Oshikango railway line had created another route for the transportation of goods between the southern and northern parts of the country aimed at enhancing the speedy delivery of goods and services to those destinations. The spin offs from the rail way for the region range from the transportation of goods for various businesses in the region especially Henning Crusher who mainly transport concrete stones by rail transport. The Regional Council has planned a new industrial extension at Oshivelo close to the railway line and station. This will be a strategic innovation that will ensure the efficient transportation of goods to the area. The railway has brought about inter regional linkages essential for regional economic development and it has a coverage of about 275 km across the region (Oshikoto Regional Council, 2020).

Electricity infrastructure

The importance of the availability of electricity to stimulate development cannot be over stressed. NAMPOWER is the main bulk power supplier whereas NORED and CENORED are the power distributors in the Oshikoto Region.

The Rural electrification programme has benefited many localities in rural areas. With the use of electricity in rural areas, life has changed to better. The disparity of life style which has been existing between rural and urban areas is gradually narrowed and as more and more localities are electrified areas (Oshikoto Regional Council, 2020).

At present, the same customer service offered by urban based shops and business is equally offered in rural businesses and shops, due to the introduction and use of electricity, which has in turn dramatically improved life in the rural areas where the majority of our population is residing.

Water Infrastructure

The Directorate of Rural Water Supply whose mandate is to supply water to rural areas, has worked hard to bring clean and potable water to the rural community within a walking distance of 2km. Water is supplied through pipelines, boreholes, while earth dams have been created to harvest rain water. Immense progress has been made in this area of supplying water for human and livestock consumption to rural areas (Oshikoto Regional Council, 2020).

According to 2011 census data, about 80% of rural surface area in Oshikoto Region is covered with clean water. Oshikoto Regional Council constructed a water reticulation system in Onayena and Oniipa settlements to provide water services to residents in the two settlement areas. There are various water pipelines and water points established by the Ministry of Agriculture, Water and Forestry across the region (Oshikoto Regional Council, 2020).

However, in terms of access to water and sanitation in Oshikoto Region, it lags behind the national average *(Figure 21).*

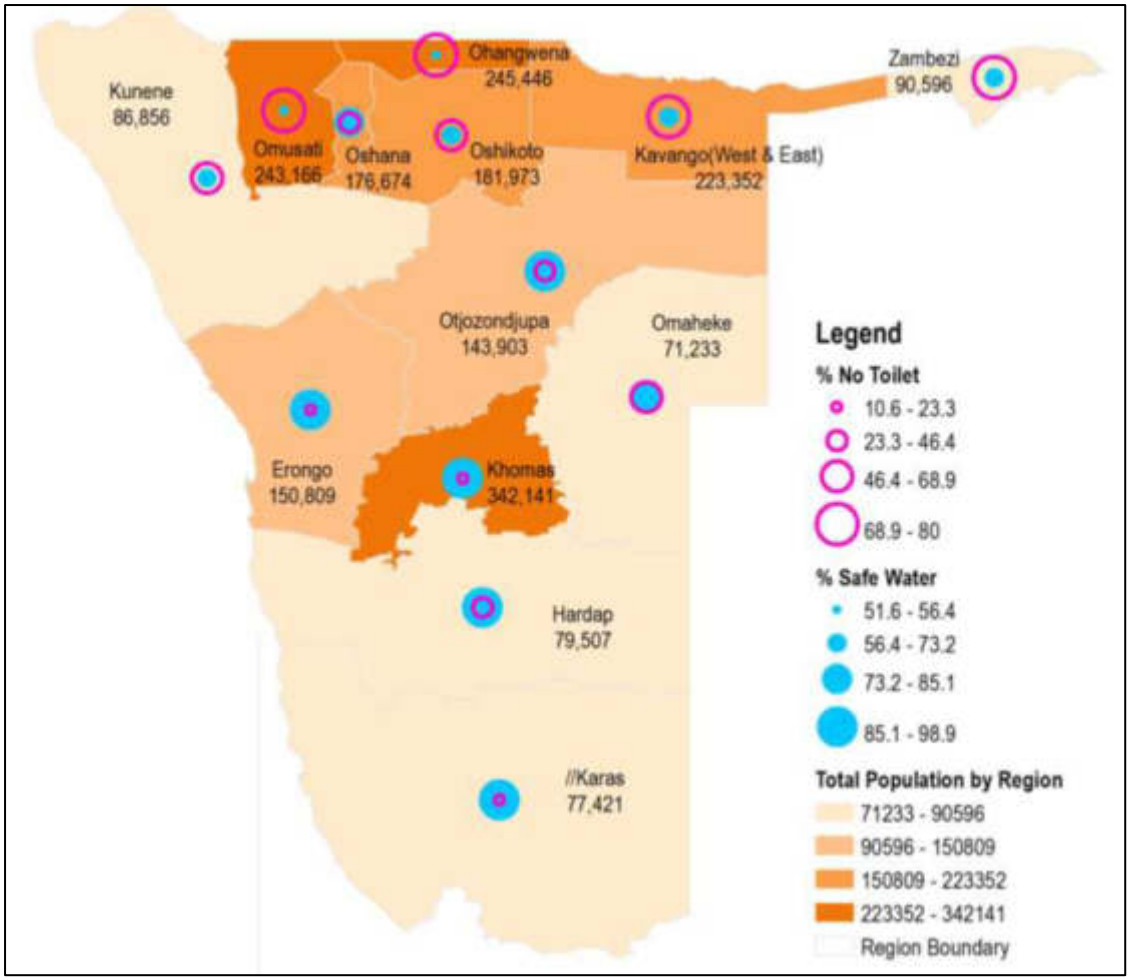

Figure 21: Access to water and sanitation in Namibia (UNCT, 2015)

Meanwhile, the local and regional authorities in the region have recorded successes in ensuring that people residing in municipal and settlement areas are supplied with clean water.

Oshikoto Region is rich with underground water in the areas of Oshivelo, Tsumeb and their surroundings. The farmers residing in those areas are making use of precious natural resource to produce fruits, maize and vegetables.

Another stream of underground water which is said to be of mineral water was reportedly discovered stretching in the areas of Okankolo and Eengodi, respectively. Experts in water resource management are planning to abstract this untapped resource to be used productively. Oshikoto Regional Council constructed a water reticulation system in Onayena and Oniipa settlement to provide water services to residents in the two settlement areas. There are various water pipelines and water points established by the Ministry of Agriculture, Water and Forestry across the region (Oshikoto Regional Council, 2020).

All local authorities in the region have waste disposal sites and sewerage treatment facilities including oxidation ponds. New waste disposal facilities were constructed in Oniipa Town as well as in Onayena and Oshivelo settlement areas.

According to the Oshikoto Regional Development Profile 2020, sanitation has been and continues to pose challenge in the rural areas of Oshikoto Region. Sanitation has not improved

and the magnitude of the sanitation backlog in rural area is increasing and deserves an attention (Oshikoto Regional Council, 2020).

Communications infrastructure

Telecommunication is provided by Telecom and MTC's networks. The services are expanded to a larger population, including those residing in rural areas, via mobile phones. To date, 90% of the population in the Oshikoto region is connected to a cellular network (Oshikoto Regional Council, 2020), provided by cellular operators, Telecommunication Limited (MTC), T- mobile and Telecom Namibia. The use of mobile phones has enabled rural communities to enjoy uninterrupted communication wherever network is available.

Internet is available in local authority areas such as Tsumeb and Omuthiya respectively, as well as in major settlement areas of Oshivelo and Onyaanya among other. Digitalization and the use of internet services is not only restricted to the major towns and settlements, but is gradually reaching rural areas, bringing under serviced and un-serviced communities into the main stream of the technology and information highway (Oshikoto Regional Council, 2020).

The Namibian Broadcasting Corporation (NBC), a public broadcaster and plays a crucial role in disseminating information to the public through radio and television. Radio was chosen by the rural community as an effective medium for transmission of much needed information. 60% of rural areas in Oshikoto Region receive a radio signal and make use of radio as an affordable communication tool for disseminating news and important information to a wider population.

According to the Oshikoto Regional Council's Development Profile (2020) there is a serious need for the establishment of the NBC regional bureau in the Oshikoto Region. Initiatives to introduce a northern based and/or Oshikoto regional newspaper is being encouraged by Council.

5 ECONOMIC PROFILE

Oshikoto Region's economic environment is largely made up by farming, tourism and mining. The Region is strategically located to attract economic activity and opportunities as it stretches north-wards, connecting the north and southern areas of Namibia.

Farming

Agriculture is one of the key sectors in the Oshikoto Region. The Region is characterised by extensive woodland areas with vast amount of arable land, soils of high inherent fertility, a fragile ecosystem, and average rainfall. These conditions are conducive to increase and sustain the levels of agricultural activity, real farm incomes, and national and household food security, within the context of Namibia's fragile ecosystem.

Oshikoto Region is 'divided' into two different land tenure regimes. The southern part of the Region consists of large-scale farming areas under freehold title, while the north-western parts remain under communal land. Most of the households in the communal area engage in the subsistence farming. Commercial farming is mostly practiced beyond the veterinary cordon fence popularly known as the red line. The sale of agricultural products in the Region is quite dominant in the local markets.

There are 255 farms of which 179 are commercial farms with freeholds, of which 51 are owned by emerging farmers (AALS), 64 plots and 12 resettlements. The rest of the farming area is a communal land (Oshikoto Regional Council, 2020).

Livestock production is the most common land use in Oshikoto Region. The grazing area is relatively good during the rainy season; however, it starts to deteriorate when drought strikes from June to December. The condition of livestock varies from area to area depending on the availability of pastures.

According to disease status, Namibia is divided into three zones. Free zone which is south of the veterinary cordon fence (VCF), Protection zone in the North central regions, Kavango West and Kunene North Regions and the infected zone which includes Zambezi region and Kavango East region. Hence, movement of clovenhoofed animals and their product are not allowed into the south of cordon fence (free zone). Movement of small stock to the free and surveillance zone is only allowed after 3 weeks quarantine period followed by negative serology in sentinel cattle running together with them (goats) during the period.

There are privately owned butchery and abattoir available in Omuthiya (Ha Na He butchery abattoir) and public Crush pens, Quarantine farms and auctions facilities DAPEES in collaboration with other main stakeholders in the Agriculture Sector managed to coordinate and established the development of the following Livestock Marketing Infrastructures:
The Seventeen (17) multipurpose kraals / holding pens and two handling facilities have been constructed in the Region to be used for livestock vaccination, information / permit days and for animal treatment respective, localized auctions and other related activities (Oshikoto Regional Council, 2020).

The Region has following livestock facilities: about 454 crush pens, one quarantine farm (Oshivelo quarantine) and two (2) auction pens (Onyuulaye and Omuntele) build by the Government through the Ministry of Agriculture, Water and Forestry, one Private Auction Kraal (Shondili Auction) and seventeen (17) Holding pens located in all Constituencies within the Oshikoto Region (Oshikoto Regional Council, 2020).

Some freehold farms use irrigation and produce citrus trees in areas where good quality groundwater is available. Both cereal and vegetable crops are grown in the region. As far as cereal crops are concerned, pearl millet, sorghum and maize are grown in the region. The Region's average cereal production for the last 3 years has been 18,400 tones while the 13 years average stands at 17,500 tones (Oshikoto Regional Council, 2020). Tsumeb district forms part of the maize triangle where a substantial amount of maize, fruits and vegetables are produced.

The Region has one of the Government National Strategic Food Reserves Centre which is being managed by Agro Marketing and Trade Agency (AMTA) and it is situated in Omuthiya town. The centre has five silos with total storage capacity of 4000MT. Three bins are used to store white maize and two bins are for Mahangu grain (Oshikoto Regional Council, 2020). Communal farmers in region who produce Mahangu surplus on annual basis deliver their grain to the centre. When grains are delivered, they are graded according to Namibia grain grading standards and farmers are paid per kg delivered. White maize is sourced from commercial farmers in area of Oshivelo, Tsumeb, Tsintsabis and few communal farmers in Nehale Lya Mpingana constituency.

There is the tree planting and orchard development project that is run in the Oshikoto Region. It covers seedling production and orchard development and other on-farm forestry activities on private farms with the aim to increase forest cover and income generating activities. Onankali district forestry office produces seedlings with a target of 16 000 seedlings every year. The seedlings range from fruit trees, shade trees and ornamental trees. These seedlings are sold and donated to the public and private institution for planting with the purpose to improve forest cover in the region.

The Directorate of forestry has established 7 orchards in the Region. *Nahas Angula Orchard, Onandhi Orchard, Onameho Mayego Orchard, Omangundu Orchard*, Onambango Orchard are located in Onyaanya Constituency. *Omuthiya Orchard* is in Omuthiya Constituency and *Onambiga Orchard* in Eengodi constituency totaling an area of 46 ha. All the orchards are at a fruiting stage and produce about 15 tons of fruits per year. The well-known Onankali Eucalyptus plantation is covering an area of 50 ha.

Marketing infrastructure is poorly developed in the Oshikoto Region. Information on how the communal farmers are to commercialize their farming practice is highly needed which will probably change their traditional perception of keeping livestock as an indication of social status. Similar information is needed on farming method regarding mahangu crop farming and how to be active in a Commercial competitive market.

Oshikoto Region has some of the oldest resettlement farms. In 2016 the Ministry of Land Reform (MLR) had a total of 24 resettlement farms in Oshikoto's freehold sector. In addition, there are 100 surveyed farm units in the region's communal area (Werner, W. & Bayer, C.-T.,2016).

The MLR is mandated to administer and ensure equitable access to Namibia's land resource. In order to achieve its mandate, the MLR has a Directorate of Regional Programme Implementation (one of the directorates in land administration). The Directorate of Regional Programme Implementation consists of fourteen (14) Divisions, i.e. Division Lands for each of the fourteen (14) Regional Offices. The primary objective of the Directorate is to partake in the implementation of the Communal Land Reform Act, Act No. 5 of 2002 (CLRA) and the Agricultural (Commercial) Land Reform Act 1995, (Act No. 6 of 1995)(ACLA) and other land reform policies and legislations. By implementing both Acts as mentioned, each region has to establish a Communal Land Board (except Khomas, since it does not have communal land) and Sub-Regional Resettlement Committees of the Land Reform Advisory Commission (LRAC). The main purpose of this programme is to ensure that all Namibians have equal access to land and security of tenure regardless of their standing in society, that they can become self-supportive and promote sustainable use of land as a resource. Further purpose is to ensure socio-economic planning and sustainable development of communal residents and to improve food security through increased agricultural production and other income generating activities.

Below is the *Figure 22* that illustrates the map of the locations of the resettlement farms in the Oshikoto Region.

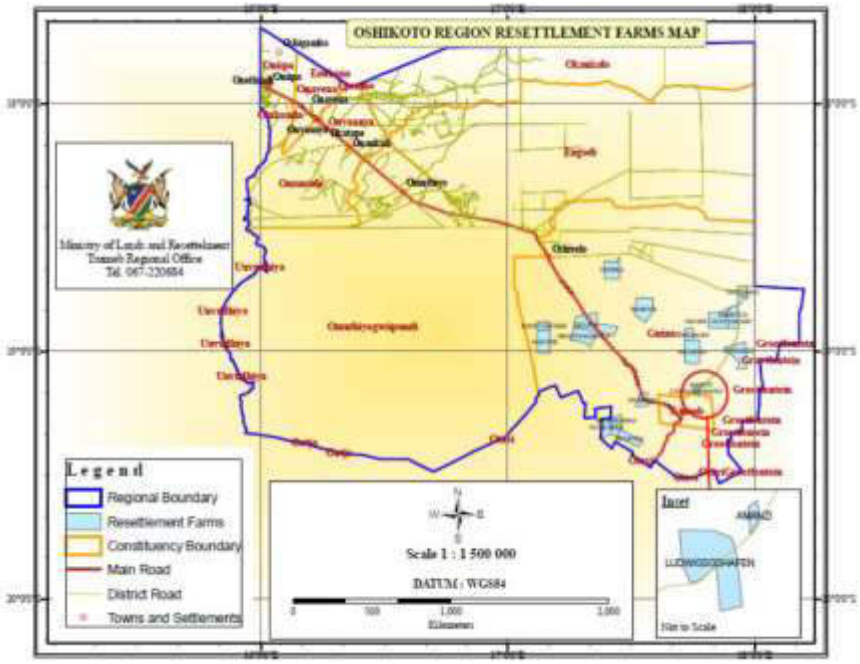

Figure 22: Oshikoto Regional Resettlement farms (Source of data: Oshikoto Regional Council, 2020)

Four of these units house the MAWF's Livestock Development Centre (LDC) at Okapya. Okapya Livestock Development Centre is in the Mangetti Blocks in the Guinas Constituency and is being developed to improve agricultural productivity in terms of quality and quantity in order to raise the living standards of the communal farmers through optimizing livestock production systems (Oshikoto Regional Council, 2020). These farms were established primarily for the development of livestock and beef production in the 1980s (Werner, W. & Bayer, C.-T.,2016). An area of about 28 hectares is earmarked to be planted cultivated pasture as measure to mitigate drought, natural disasters, among others. Good quality indigenous breeding bulls (Sanga breed) are being availed through BullScheme programme to communal farmers to improve their herds (Oshikoto Regional Council, 2020).

In the wake of the Odendaal Commission (Republic of South Africa, 1964), 100 farms were surveyed in the Mangetti area, mostly on and added to the former native reserve as a result of the Commission's recommendations.

The original rationale for surveying and developing the Mangetti farms was to promote commercial farming in the communal area.
The Mangetti block is regarded as jewelry of Northern Communal Area (NCA). These are individually fenced 100 farms located on the east of Oshivelo and just north of the muramba-Owambo in Oshikoto Region. Out of these 100 farms, the previous government leased – on a long-term basis – 96 farms are leased to individual farmers. The Ministry of Agriculture, Water and Forestry occupies the remaining four farms and this is where Okapya Livestock Development Centre (OLDC) is located.

However, many farms are still operating as cattle posts for their owners 1980s (Werner, W. & Bayer, C.-T.,2016). According to the extension officer at the Okapya LDC, Mangetti farmers generally do not have clear production objectives, rates of off-take are low, while cows are being milked by farm workers, leading to high mortality rates among calves. The farmers were not selling old and unproductive cows and were not buying lick and supplementary feed. The state of agriculture in the Mangetti area to a large extent to many people was a farming on a

part-time basis. Cattle are 'wild' because they are not properly looked after, and this, combined with insufficient infrastructure, impacts negatively on the marketing of cattle (Werner, W. & Bayer, C.-T.,2016).

According to the Werner,W. and Bayer, C.T. (2016) research, the boundary fences were properly maintained on 50% of the farms. On the other farms the fences were dilapidated. Four farming units had to share one water point. Out of the 38 boreholes, 10 had been privately drilled, and out of the other 28, eight were dysfunctional and 20 had private pumps. Altogether 28 farms were overstocked, although it was suspected that some farmers did not give the correct stock numbers. Only 16 of the 88 farmers interviewed were farming with livestock only. The other 72 were rearing livestock and practicing cultivation. On four farms the occupants ran shebeens, where they brewed and sold alcohol.

Nevertheless, the communal land still has potential for development of both crop and livestock production through dedicated training and extension services and by opening up vast unutilized areas for production (Oshikoto Regional Council, 2020).

Fisheries

The Oshikoto Region does not possess potential features for the fisheries and marine resource sector (Oshikoto Regional Council, 2020). There are few natural water sources to harbor fish and other marine resources. There are no projects in the Region implemented under this sector. However, some communities do get an opportunity to catch fish after good rains from the oshanas and temporary rivers.

Forestry

Forestry is one of the key economic sectors. Even though the use of forest produce in communal areas are mainly for own use, most commercial farmers use forest produce for commercial purposes such as the production of charcoal and fire wood both for domestic use and export. A total of 16 724 tons of charcoal was produced in the Oshikoto Region in the 2018/19 financial year (Oshikoto Regional Council, 2020).

Community forest is one of the programs of the Community Based Natural Resources Management (CBNRM) with the aim to sustainably manage forest resources in communities thus enabling communities to generate income from those resources. There are two gazetted community forests in the Oshikoto Region namely: *Oshaampula Community Forests and Ohepi Community Forests.* Plans are under way to have Onkumbula Community Forest gazetted as well. These areas are all situated in Okankolo Constituency. These community forests are under the management of communities themselves with technical support from the directorate of forestry in the ministry of agriculture, water and forestry. The community generates income from selling fire woods, poles and other forest produce and use the money for community development. The community forest covers approximately an area of 12987 ha (Oshikoto Regional Council, 2020).

Tourism

Tourism is an important industry in Namibia. It contributes significantly towards the Gross Domestic Product, making it a valuable sector within the country. The total contribution of the tourism industry to the Namibian GDP was 15.1% (N$13,405 million) in 2012. In 2012, travel and tourism directly supported 22,500 jobs (4.6%) in Namibia and the total employment contribution of the tourism industry in Namibia was 97,000 jobs (WTTC, 2013).

Unlike other segments that have not been spared by the harsh economic challenges, the tourism industry has witnessed the growth over the past two years and it is estimated there will be a further increase by 9.7% per annum from 2013 - 2023 (WTTC, 2013).

Tourism is often cited as one of the major contributors to the regional economy. It is a sector that has a potential to offer employment opportunities to rural communities of the region.
The Oshikoto Region is well located with tourist attractions sites which include Etosha National Park, Otjikoto Lake, Guinas Lake, the Nakambale and Helvi Kondombolo Cultural Villages, Tsumeb museum.

There are a number of conference and guest facilities available such as the Makalani Hotel, Minen Hotel, Punyu Hotel, Okashana Rural Development Centre, Mokuti Lodge, Road House Guest house, Torpoh guest house, Dross and ELCIN Guest house.

On commercial farmland, game is managed individually or as conservancies. Commercial game farming, hunting farms and eco-tourism provide economic income for farmers. Several hunting and game farms and various lodges, such as Emanya lodge, Omashale lodge among others, near the Etosha National Park.

Etosha National Park
Etosha National Park is the biggest and most famous tourist attraction area in the Region. The main characteristic is a salt pan and abundant wildlife that concentrates around the waterholes, offering opportunities of viewing wildlife such as elephants, giraffes, rhinos, lions, leopards, impalas, kudus, zebras, springbok and many more. At the same time Etosha National Park is one of the most accessible game reserves in Namibia and Southern Africa.

International, local tourists and guests visiting the Region enjoy the hospitality offered by different hotels, lodges and other accommodation facilities. The park has five tourist resorts – Okaukuejo, Namutoni, Halali, Onkoshi Camp and Dolomite Camp. With the opening of the King Nehale Gate on the northern boundaries of the Etosha National Park, and the tourism concession awarded to the King Nehale Conservancy, more tourism related opportunities are emerging. Newly built King Nehale Conservancy & Gondwana Joint Venture Lodge that is located on the Andoni plains, just 1 km from Etosha National Park's northern part at King Nehale Gate, was officially opened on 28 April 2020. Mokuti Etosha Lodge that is situated 5 minutes' drive from the eastern Von Lindequist gate entrance of the Etosha National Park offers 106 rooms to tourists.

Otjikoto Lake
Lake Otjikoto is situated close to the mining town of Tsumeb and is a part of an underground river system. The lake was exposed when the roof of what was a large dolomite cave fell in. The lake is small with a diameter of about 102 m, but very deep, with a depth estimated to be in excess of 142m in places. The lake is situated near the town of Tsumeb and is en-route from there to the Namutoni entrance to the Etosha National Park. For many centuries, the lake was the biggest copper market in the country with its rich copper deposits. The local San people sold copper from Tsumeb to the Ovambo tribe and the Aandonga using the lake as a meeting point where they bartered various objects. In 1915, the Germans, who once occupied Namibia, discarded a huge load of war equipment into the lake. Some of the weaponry was recovered and one can see it on display in the Tsumeb Museum, while a large part continues to be somewhere at the bottom of the lake, along with the war chest. Legend also has it that gold

bullion was sunk into the lake. At least two cannons, along with quantities of ammunition, are still in the lake and can be viewed with a special diving permit.

Otjikoto is considered a premier diving site in Namibia. It is shaped like an upside down mushroom and is a picturesque sight with tranquil emerald green waters. The rare and endangered Otjikoto Tilapia lives in this lake along with a unique species of dwarf bream and cichlid.

Guinas lake
A little southwest of Otjikoto lake is Guinas lake, it is located 38 kilometers north of Tsumeb, near the D3043 road. Guinas lakeis even deeper and more scenic than Otjikoto lake. Both lakes are in the Otavi mountain land, rich in dolomite and limestone that is more than 700 million years old. Guinas lake is about 100m deep and shaped like Otjikoto and has a spectacular underwater cave under its surface with stalagmites and stalactites.

There are only two natural lakes in Namibia and of which Guinas lake is the largest. It is a sinkhole lake, created by a collapsing karst cave.

Lake Guinas is home to Tilapia Guinasana, a mouth-breeding species of fish that was endemic to this lake. It has later been introduced to Otjikoto lake, as well as into few farm dams nearby. The claim that Lake Guinas is indeed connected to Lake Otjikoto by underground caves is frequently made but not proven as yet. The lake is situated on private farmland but can be visited with the permission of the owner (Oshikoto Regional Council, 2020).

Nakambale Museum and Rest Camp
Nakambale Museum and Rest camp - Olukonda was founded in 1871 as one of the first Finnish missions in Owamboland. Since 1880 it was home to the Finnish missionary Martti Rautanen, nicknamed Nakambale by the locals. In 1889 Nakambale built the first church in the north of Namibia and in 1893 a house for missionaries. The buildings still exist and since 1992, it was identified as one of the National Namibian Monument. It has 5 traditional huts, 5 permanent tents and a spacious camping area. Nakambale Museum and Rest camp is currently managed and maintained by the Evangelic and Lutheran Church of Namibia under the auspices of the local people owner (Oshikoto Regional Council, 2020). It is located 8km before Ondangwa, there is a sign indicating a tarred/gravel road on the left hand side, the D3629.

Tsumeb Museum
Tsumeb Museum is located on Tsumeb's Main Street, the Tsumeb Museum houses some excellent displays of the areas' rare minerals. The museum focuses on the mining history of the town, and also has a collection of San and Himba people artefacts. This is also a place to learn a little history about the German colonial history in Namibia.

Omandongo mission station
The history of Finnish-Namibian relations is incomplete without mention of Omandongo. Omandongo is a village located in the northern part part of Namibia specifically southern part of Onayena constituency, Ondonga district just 20km from Ondangwa. The Finnish Missionary Society began its missionary work in Omandongo in 1870. This was the first mission station for Finnish missionaries in the whole world. It was occupied by Finnish missionaries during 1870–88. It consists of about 106 inhabitants. During colonial rules several fights took place in this village. Wthe help of small business center, Omandongo established its community trust

known as Omandongo Community trust which will be run by Onayena community as tourist center.

The majority of tourism establishments are found within the vicinity of the Etosha National Park and are catering to the tourism sector. During the Covid-19 pandemic the tourism activities in the area of interest as well in the whole country have subsided.

Trade and industry

Trade in Oshikoto Region involves formal and informal traders ranging from multinational retail businesses to vendors selling home-made food (fat cakes, cooked meat, fish etc) home-made drink (Oshikundu) and many others. Apart from the informal traders, most of the businesses are liquor wholesalers and outlets as well as small shops, selling basic amenities and foodstuff.

Fuel filling stations can be found in all three towns of Tsumeb, Omuthiya and Oniipa. There is also a new service station at Elambo in the Okankolo constituency which mainly serves the rural people in the remote constituencies of Okankolo, Eengodi and Nehale Lya Mpingana. A fuel station can also be found at Oshivelo. Etosha National Park also hosts a fuel station which mainly serves tourists and visitors at the popular tourism site. Onayena residents recently witnessed the opening of a new service station (Oshikoto Regional Council, 2020).

A big shopping mall was constructed in Tsumeb Town which houses a number of retail shops, private doctor and pharmacy. Various developers have constructed shopping complexes in the town of Omuthiya and the two settlement areas of Onayena, Oshivelo and the newly proclaimed town of Oniipa. The shopping complexes are a boost to the region's economy because employment opportunities are created when new shops are established. The major retail shops in the region are Shoprite U save, Shoprite, Pick 'n Pay and Spar
all based in Tsumeb Town with the exception of U- save, Ok food and Choppies which are based in Omuthiya Town (Oshikoto Regional Council, 2020).

Most of the industrial activities are taking place in Tsumeb town and the surrounding areas. This is for the mere reason that Tsumeb area has mineral deposits mainly copper. For a very long time in history, mining was the main economic activity of Tsumeb town. For that reason mining and businesses serving mining industry were dominating in the area. The town itself was fully dependent on the mining. Though, when Tsumeb became the Region’s administrative centre it boosted the development of several non-mining businesses and services, particularly local business developments. With time the main focus has moved from mining to other economic activities, such as tourism, industrialization and retail trade. With that Tsumeb has emerged as self-sustainable urban centre with diversified economic activities (Stankevica, 2015). Until 2008 Tsumeb was a regional centre for Oshikoto Region.

Oshikoto Region has a number of business centres, such as Omuhama Business Hub (Omuthiya), Okutopola Community Market (Onethindi), Sida! Hanab Community Market (Tsumeb), Omulunga Community Market (Onayena) and Trade Centre (Tsumeb). The primary purpose of these infrastructures is to provide affordable rental spaces to business people with a special focus on entrepreneurs. Business personalities from all walks of life can be found in such infrastructures of the Ministry. Such infrastructures are also used for skills development as well as experimenting to produce new products. It should however be stressed here that such facilities must be limited to entrepreneurs who want to venture into manufacturing as opposed

to retailing. Other MITSMED infrastructures to be developed include: Onathinge Community Market, and Oshivelo Community Market (Oshikoto Regional Council, 2020).

Omuthiya SME Park is situated in Omuthiya Town along the B1 road and it comprises of ten (10) units. There is also Omuhama business Park next to Omuthiya SME Park which is made up of six (6) units. These units are mainly for SME businesses to lease at an affordable rental rate (Oshikoto Regional Council, 2020).

Sida! Hanab Community Market is situated in Tsumeb town along the B1 road. It is comprises of seven (7) units were different MSMEs are renting at a very affordable rate. The MSMEs renting these units ranges from Tourist Information Centre, Cold Room Facilities, 7 Lines Shops, Boutique, Hair Salon, Butchery, IT Office, 33 Vendor units and 4 Secure Vendor units (Oshikoto Regional Council, 2020).

Tsumeb Industrial Park comprises of twelve (12) Industrial workshops. The primary purpose of this Industrial Park is to provide trading facilities in a form of workshops to Namibian Small & Medium Manufacturers for the purpose of value addition. The Tsumeb Industrial Park is being constructed at the tune of N$ 38 Million, currently at its final stage of being completed; soon it will be in operation (Oshikoto Regional Council, 2020).

Oshikoto Region offers exciting business prospects to companies especially as there is an increased demand for construction material. This will be necessitated by the construction of roads and housing. Henning Crusher is the main producer of building materials such as bricks, concrete stones and sand in the region based in Tsumeb. Henning crusher
manufactures large quantities of bricks, concrete stones and sand and enjoys are robust customer base in the areas in the north, north east and south of the country.

Most of the manufacturing and value addition activities in many parts of the Region are done on a small scale. Entrepreneurs in general engage in different activities starting from traditional baskets (Iimbale) to manufacturing of bricks, donkey carts and car trailers among others. There are some noticeable small manufacturing businesses in the Region which include: Onankali Mahangu Paper Making Cooperative which manufactures (envelopes, gift pouch, papers, and handicrafts) and Nailoke Solar Stoves which manufactures solar stoves.

Mining

Tsumeb is well known for its copper mine, which was built in 1961-1962 and housed one of the few commercial smelter plants in Africa.

It is one of the largest capital projects in Namibia's mineral processing industry, is the N$2.7 billion gas-cleaning and sulphuric acid plant at Dundee Precious Metals' copper smelter in Tsumeb. The smelter was constructed in the early 1960's to process concentrate from the Tsumeb copper mine and other mines in the country. It is linked by rail to the Atlantic port of Walvis Bay in Namibia. The smelter employs approximately 800 people. According to the Dundee Precious Metals information (Dundee Precious Metals. (n.d.) the smelter is one of only a few in the world that can treat complex copper concentrates. Blister copper and sulphuric acid are smelter products. The blister copper is delivered to refineries in Europe and Asia for final processing to copper metal. Sulphuric acid is a critical component in the mining industry, particularly for uranium and copper production businesses. Thus, the smelter can take a by-product of copper and turn it into something of value for Namibia (Dundee Precious Metals,

n.d.). The estimated life of mine is until 2038 (Chamber of Mines, 2020).

In 2020 Dundee Precious Metals Tsumeb (DPMT) employed 739 permanent and 52 temporal workers, and 633 contractors (Chamber of Mines, 2020).

Increasing the share of manufacturing in the economy is seen as key to job creation and economic growth. This is to be achieved through both diversification of the export base by exporting of processed raw materials as well as through import substitution of manufactured goods. More diversification of the Oshikoto Region economic base is needed.

The Region's mineral resources particularly the copper was annually showcased through the copper festival which attracted thousands of visitors to the Tsumeb industrial town between October and November each year. Mining remains a large employer in the Region after the agricultural sector.

According to the Ministry of Mines and Energy Namibia Mining Cadastre (*Figure 23*) there are some Exclusive Prospecting Licenses that are active in Oshikoto Region. They are located mainly in the southern part.

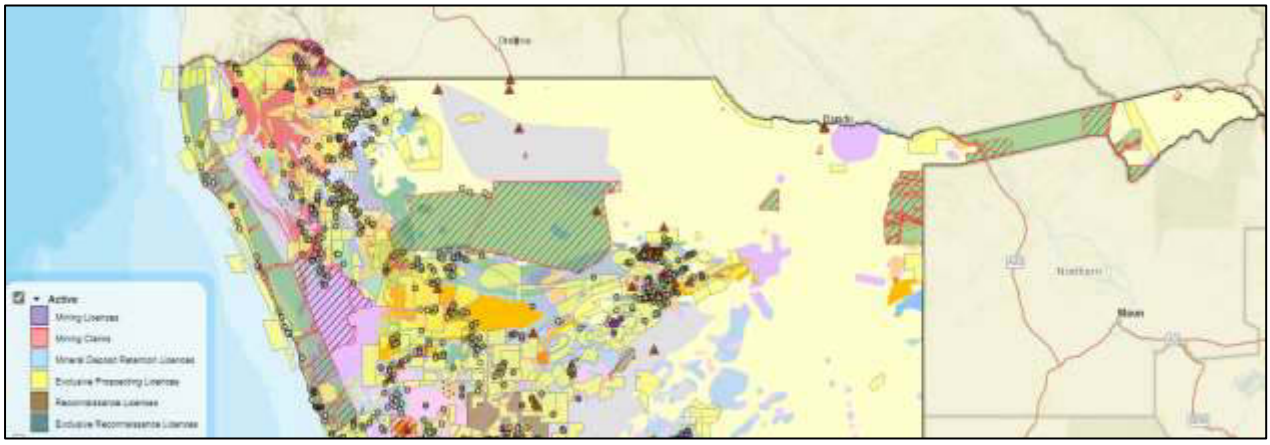

Figure 23: Namibia Mining Cadastre on 25 February, 2022 (Source of data: www.mme.gov.na.)

Although a number of Exclusive Prospecting Licenses (EPLs) have been granted by the Ministry of Mines and Energy (MME) to companies for prospecting in the region, no concrete evidence of viable mineral resources have been discovered yet.

According to the government officials the Oshikoto Region has an enormous economic potential, specifically in the areas of mining, tourism, livestock and crop farming (Sirirka, 2021, October 26).

It is also noted that the impact of Covid-19 pandemic on the economy was huge, where businesses were not operating at optimal levels. All sectors from shebeens, SMEs and tourism and hospitality establishments were severely affected in Oshikoto, and many have failed to revive themselves despite regulations having been relaxed. Covid-19 has taken a huge toll on the earnings.

6 SUMMARY AND CONCLUSION

The socio-economic information is summarised as follow:

- The area of interest is populated with around 31 660 people, this includes 3 constituencies - Guinas, Eengodi and Nehale LyaMpingana.
- There are more females than males, 51.8% and 48.1% accordingly.
- Eengodi and Nehale LyaMpingana constituencies has more youthful population than Guinas constituency. Though Guinas has highest percentage of working age population among the three affected constituencies and which is above the average for Namibia (57.3%).
- Approximately 62% of population aged 15 years and above in Oshikoto Region were never married, while 22.7% of the population were married with certificate.
- There are more single males in Nehale LyaMpingana and Eengodi constituencies, while Guinas constituency has more single females.
- Oshikoto teenage pregnancy rate stands at 1.4% of all children ever born to females younger than 20 years of age.
- 6.7% of the total population of Oshikoto Region has some kind of disability. The proportion of people living with disabilities is higher in rural areas (6.9%) than in urban areas (5.4%).
- The physical impairment of lower limbs is the most common type of disability affecting about 24% of the population with disabilities in Oshikoto Region.
- Oshikoto Region's life expectancy is at 61.8 years for females and 52.2 years for males. This is a considerable improvement in comparison to the earlier Census 2001 when female's life expectancy was only 49.8 years and 50 years for males.
- Population of Oshikoto Region has been growing steadily, yet at a slightly slower paste than average for Namibia. In a period between 2001 and 2011 the annual growth rate for Oshikoto was 1.2% and then it slightly picked up to 1.4% in 2016.
- The projected population of Oshikoto Region for 2030 is 235153 people, with 48.4% being male and 51.6% female.
- The area is sparsely populated in east, south and south east part (Etosha National Park) of the Oshikoto Region and densely population in northwest part of region.
- There is a noticeable movement of people from rural to urban areas. The long-term migration for Oshikoto Region is negative. There were more people leaving the area than coming in.
- The literacy rates in Oshikoto Region is 84%, with females scoring higher rate of 87% and males lower 81%.
- The literacy rates for affected constituencies had lower rates than the rest of the Oshikoto Region. Particularly low literacy rates were in Guinas constituency where only 64% of males and 56% of females were literate.
- Oshikoto Region's unemployment rate is 36.2% which is above the unemployment rate for Namibia - 33.4%.
- The large unemployment rate could be attributed to the limited formal employment within the region as the majority of households still obtain income from subsistence activities.

- Largest share of employed people work as skilled agricultural workers, in elementary occupations, service workers and craft and related trade workers. Nehale LyaMpingana Constituency has a significant number of employed who work in armed forces.
- Dependency on old-age pensions, cash remittances, retirement fund, orphan or disability grants is high and indicates dependency from income that is coming from social services or monies that are not generated by themselves. Around 15% of Eengodi households, 13.5% Guinas households and 9.1% Eengodi households depend on old-age pensions.
- In 2011, the incidence of poverty in Oshikoto Region was 43 % and it represented a 15-percentage point reduction from the 2001 figure of 57 %. Though there was an improvement since 2001, Oshikoto Region is among the three poorest regions in Namibia.
- Oshikoto household consists of 4.3 persons on average. There are more female headed households than male headed households.
- Around 2% of households are headed by children who were 18 years and younger. Oshikoto Region has one of the highest number of households headed by children! Furthermore 0.7% of households are headed by orphaned children.
- Traditional dwellings are the most common type of housing unit, making up 69.7 % of all households in Oshikoto Region, followed by detached houses (14.2%) and semidetached houses (6.1%).
- Household's main source of energy for cooking was fire wood, 70.9% of all households using fire wood for cooking. The main source of energy for lighting is battery lamps, torches and cell phones - 56.6% of Oshikoto households
- 93% of households have safe drinking water, with 30.3 % of the households having access to piped water inside the house and 38.2% of households having piped water outside.
- Oshikoto Region has traditionally been occupied by San groups, mainly Hai||om and with a smaller proportion of !Xun – living mostly in the freehold areas, with just a few groups living in the communal areas. After Independence many Hai//om farmworkers were dismissed and moved to towns or newly established resettlement farms, such as Tsintsabis. In 2012 the Hai//Om San community living at Oshivelo was resettled to Ondera. In 2018 Ondera had already 500 households.
- Oshikoto Region's economic environment is largely made up by farming, tourism and mining.
- Agriculture is one of the key sectors in the Oshikoto Region. Region is 'divided' into two different land tenure regimes. The southern part of the Region consists of large-scale farming areas under freehold title, while the north-western parts remain under communal land.
- Most of the households in the communal area engage in the subsistence farming. Commercial farming is mostly practiced beyond the veterinary cordon fence popularly known as the red line.
- Tourism is often cited as one of the major contributors to the regional economy. Etosha National Park is the biggest and most famous tourist attraction area in the Region. Other tourist attraction sites are: Otjikoto Lake, Guinas Lake, the Nakambale and Helvi Kondombolo Cultural Villages and Tsumeb museum.
- Trade in Oshikoto Region is represented by formal and informal traders ranging from multinational retail businesses to vendors selling home-made food (fat cakes, cooked meat, fish etc) home-made drink (Oshikundu) and many others. Apart from the informal traders,

most of the businesses are liquor wholesalers and outlets as well as small shops, selling basic amenities and foodstuff.

- Tsumeb is well known for its copper mine, which was built in 1961-1962 and houses one of the few commercial smelter plants in Africa. Dundee Precious Metals' copper smelter is one of only a few in the world that can treat complex copper concentrates and employs approximately 800 people. The estimated life of mine is until 2038.
- According to the government officials the Oshikoto Region has an enormous economic potential, specifically in the areas of mining, tourism, livestock and crop farming.
- Impact of Covid-19 pandemic on the local economy was huge. All sectors from shebeens, SMEs and tourism and hospitality establishments were severely affected in Oshikoto, and many have failed to revive themselves despite regulations having been relaxed.

The Table below presents potential positive and negative impacts and offers enhancement measures for positive impacts. The associated negative impacts could be mitigated with mitigation measures, which are also offered in the Table below.

Potential Positive Impacts	**Enhancement Measures**
Direct economic impact would arise from employment opportunities for unskilled or semi-skilled workers. Through the provision of employment. This would positively contribute to the quality of life of these people. Local economy could be boosted from products and services purchased by employees and contractors and with the increased availability of money broadening the economic base and boosting the economy at the Constituency level as well as regional level.	The exploration company: ▪ Could stipulate a preference for local contractors in its tender policy. The procurement of services and goods from local entrepreneurs and the engagement of local businesses should be favoured and promoted providing that it is financially and practically feasible. ▪ Could develop a database of local businesses that qualify as potential service providers and invite them to the tender process. ▪ Should scrutinise tender proposals to ensure that minimum wages were included in the costing. ▪ Could stipulate that local resident should be employed for temporary unskilled/skilled and where possible in permanent unskilled/skilled positions as they would reinvest in local economy. However, due to low skills levels of the local population, the majority of skilled positions would be filled with people from outside the area. ▪ Ensure that contractors adhere to Namibian Affirmative Action, Labour and Social Security, Health and Safety laws.
Opportunities for skills development. Limited.	▪ Project offers experience and on job skills development, particularly for low or semi-skilled workers. This would raise the workers experience and skills to secure jobs in future. ▪ Promising employees could be identified and training and skills development programme could be initiated. ▪ The project could organize business partnerships with local entrepreneurs or small SMEs. ▪ Service providers to provide opportunities for skills transfer.

Potential Negative Impacts	Mitigating Measures
In-flux of workers employed by contractors as well as a potential influx of job seekers, resulting in potential increase of informal settling in the area. The influx of opportunistic job seekers may result in increased numbers of opportunistic criminals.	▪ Addressing unrealistic expectations about the job opportunities
This could also lead to the 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.	▪ Where workers to be housed in safe, well-equipped exploration camps, strict control of access should be implemented and no non-authorised people allowed on the premises. ▪ Employees should be encouraged and assisted to visit family on regular basis and subsidised transport could be provided when employees go on leave. For those workers staying on camp during the weekends, the provision of free transport to religious activities on Sundays could be considered. ▪ Employees should have respectful attitude towards local people practising local culture, traditions and practices, without interferences. ▪ ▪ Develop strategies in coordination with ATC, MoHSS. MOE and local NGO's to protect the local communities, marginalized communities and especially young girls. ▪
Potential harmful interaction between workers employed form outside the area and the local residents.	▪ When employees contracts are terminated or not renewed, contractors should transport the employees to their hometowns within two days of their contracts coming to an end. Proof needs to be provided to the exploration company.
Increased covid-19 rates during the global Covid-19 pandemic if the health restrictions and protocols are not followed.	▪ The Proponent through the Contractor and subcontractors shall adhere to the all international, regional, and local COVID 19 health restrictions and protocols that may be in place at the time of conducting the survey.
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.	▪ Contract companies could submit a code of conduct, stipulating disciplinary actions where employees are guilty of criminal activities in and around the vicinity of the town. Disciplinary actions should be in accordance with Namibian legislation. Contract companies could implement a no-tolerance policy regarding the use of alcohol and workers should submit to a breathalyser test upon reporting for duty daily.
Increased demand on the supply of power	▪ Invest in alternative sources of power, such as solar. Utilise solar energy in the all temporal camping areas.
Increased demand on water resources	▪ Promote wise and responsible use of water.

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, crop field.	▪ The exploration company to cooperate with the adjacent communities and develop a code of conduct for exploration workers and contractors to address conflicts that may arise. The exploration company should compensate communities in full for any stock losses and/or damage to infrastructure that can be linked to exploration workers. The exploration company should ensure that all exploration workers are informed of the consequences of stock theft and trespassing on adjacent communities and should ensure that exploration workers who are found guilty of stealing livestock and/or damaging infrastructure are dismissed and charged. All dismissals must be in accordance with Namibia's labour legislation ▪ Embrace the notion of respect to property of others.
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.	The detailed mitigation measures should include following: ▪ Ensure that open fires on the site for cooking or heating are not allowed; ▪ Provide firefighting equipment onsite; and ▪ Provide firefighting training to designated survey workers.
Increased traffic, especially heavy vehicles, using public roads and safety concerns.	▪ Request that the Roads Authority erect warning signs of heavy construction vehicles on affected public roads. ▪ Ensure that drivers adhere to speed limits and that speed limits are strictly enforced. ▪ Ensure that vehicles are road worthy and drivers are qualified. ▪ Train drivers in potential safety issues. ▪ Improvement of the transport network and infrastructure.

Due to the limited scope of the proposed activity, remoteness and sparsely populated area and limited skills base the social and economic impact on the local community will most probably be limited. The larger positive and/or negative impact could be attained only in an event of a discovery of economic petroleum resources. Only then it would require more detailed study on possible social and economic impact and a broader area.

The proposed 2D seismic survey operations covering the areas of interest in PEL No. 93 will have greater positive impacts in terms of monetary contributions to the central government (Ministry of Mines and Energy) revenue. 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.

The survey is likely to be completed within three (3) months from the date of implementation and it is estimated that a total of up to forty (40) persons are likely to be involved in the proposed 2D ground seismic survey process. Thus the activity is very short term to make any considerable negative impact on social environment.

Socioeconomic impacts of the proposed project activities are likely to be minimal. 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 temporary 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. Encouraged to contribute positively to the lives of various communities, especially the marginalized that are living in the area. Assist communities where possible.

It is not foreseen to have tangible neither positive nor negative impacts on local communities, however the data that will be gathered by 2D seismic survey will considerably contribute to the improved knowledge on other potential subsurface natural resources that may be associated with the area such water, minerals, and geothermal resources.

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16 MARCH 2022

PETROLEUM EXPLORATION LICENCE (PEL) No. 93 , OSHIKOTO REGION

FINAL REPORT

DESKTOP HERITAGE IMPACT ASSESSMENT

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DECLARATION

I hereby declare that I do:

1. Have knowledge of and experience in conducting assessments, including knowledge of Namibian legislation as well as regulations and guidelines that have relevance to the proposed activity;
2. Perform the work relating to the application in an objective manner, even if this results in views and findings that are not favorable to the applicant;
3. Do not have and will not have any vested interest (either business, financial, personal or other) in the proposed activity proceeding other than remuneration for work performed.

_____

Dr Alma Nankela,
Archaeologist & Heritage Specialist

EXECUTIVE SUMMARY

A heritage site visit was carried out on a proposed 2D seismic survey for oil and gas exploration north, and east of Tsumeb within Petroleum Exploration License (PEL) No. 93 in Oshikoto region. The field survey located a number of historic and ethnographic sites found within the proposed area for 2D seismic survey considered to be significant and sensitive. Such sites require special mitigation measures. It is recommended that the project adopt the recommended measures so that the designated No-Go areas for the proposed exploration activities are excluded from the Petroleum License area until a detailed survey has been conducted.

INTRODUCTION

MEL Oil and Gas Exploration (Namibia) (Pty) Ltd (herein referred to as the proponent) holds petroleum exploration rights under the Petroleum Exploration License (PEL) No. 93 covering a total surface area of about 713,558.80ha and 1.27,632.68ha **(Figure 1)** and overlays 25 farm in the Oshikoto region. The proposed a 2D seismic survey for oil and gas exploration north, and east of Tsumeb over its license, in particular, the delineated area covering district and farm road networks as well as private and government farms, north of Tsumeb (**Figure 2**).

In Namibia, petroleum exploration is legislated under the Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991), Petroleum Laws Amendment Act, 1998, (Act 24 of 1998). As a listed activity, the project is required to fulfill the environmental requirements (the Environmental Management Act, 2007, (Act No. 7 of 2007) and its Regulations (2012), as well as other applicable national laws and Regulations subject to the type of exploration activities. Risk-Based Solutions (RBS) CC has been engaged to carry out an environmental impact assessment (EIA) of the proposed project in terms of the Environmental Management Act (2007) to support the application for Environmental Clearance Certificate (ECC) for the proposed 2D seismic survey operations. Heritage resources in Namibia are protected under the National Heritage Act (2004) and National Heritage Regulations (Government Notice 106 of 2005), and projects of this magnitude are also subject to heritage assessment. Risk-Based Solutions has accordingly appointed the undersigned, A. Nankela archaeologist, to carry out this assessment.

Terms of Reference (TOR)

The review was guided by the following objectives in effort to provide recommendations on the way forward:

1. Identify heritage resources likely to be affected by the proposed exploration activities;
2. Establish heritage sites requiring further detailed assessment or special mitigation measures to eliminate, avoid or compensate for possible destructive impacts.
3. Evaluate the nature and degree of significance, sensitivity and vulnerability of such resources to the proposed exploration activities; and
4. Formulate management recommendations for the project to be considered by the authorities for the issuance of a consent and clearance certificate.

Site visit

A site visit to some of the key areas within the proposed 2D seismic survey under PEL No. 93 was carried out from the 24th-27th February 2022 to address the objectives in the TOR to fulfill the requirement of the National Heritage Council in relation to the "Guidelines for Heritage Impact Assessment in Namibia, 2021".

Acknowledgement

Permission to carry out this assessment was authorized by the National Heritage Council of Namibia, Heritage Permit No. 2/2022 under Section 52 of the Act. In compiling and submitting this desktop report, we would like to sincerely acknowledge and appreciate the participation of local communities and farm owners within the proposed seismic survey area in the Oshikoto region for making all necessary arrangements for the interviews and site visits.

Assumptions & Limitations

This desktop assessment relied on the secondary inferences from the results of historical documentation and archaeological surveys carried out in the course of previous work in the Oshikoto region. Further, primary information was

obtained from some of the affected local communities within the same general area as the proposed project during the site visits. Based on these data, the assessment was therefore limited to surface observations and existing survey data. It is therefore possible that hidden, or buried archaeological or historical remains might be exposed during the 2D seismic survey operations or as the project proceeds.

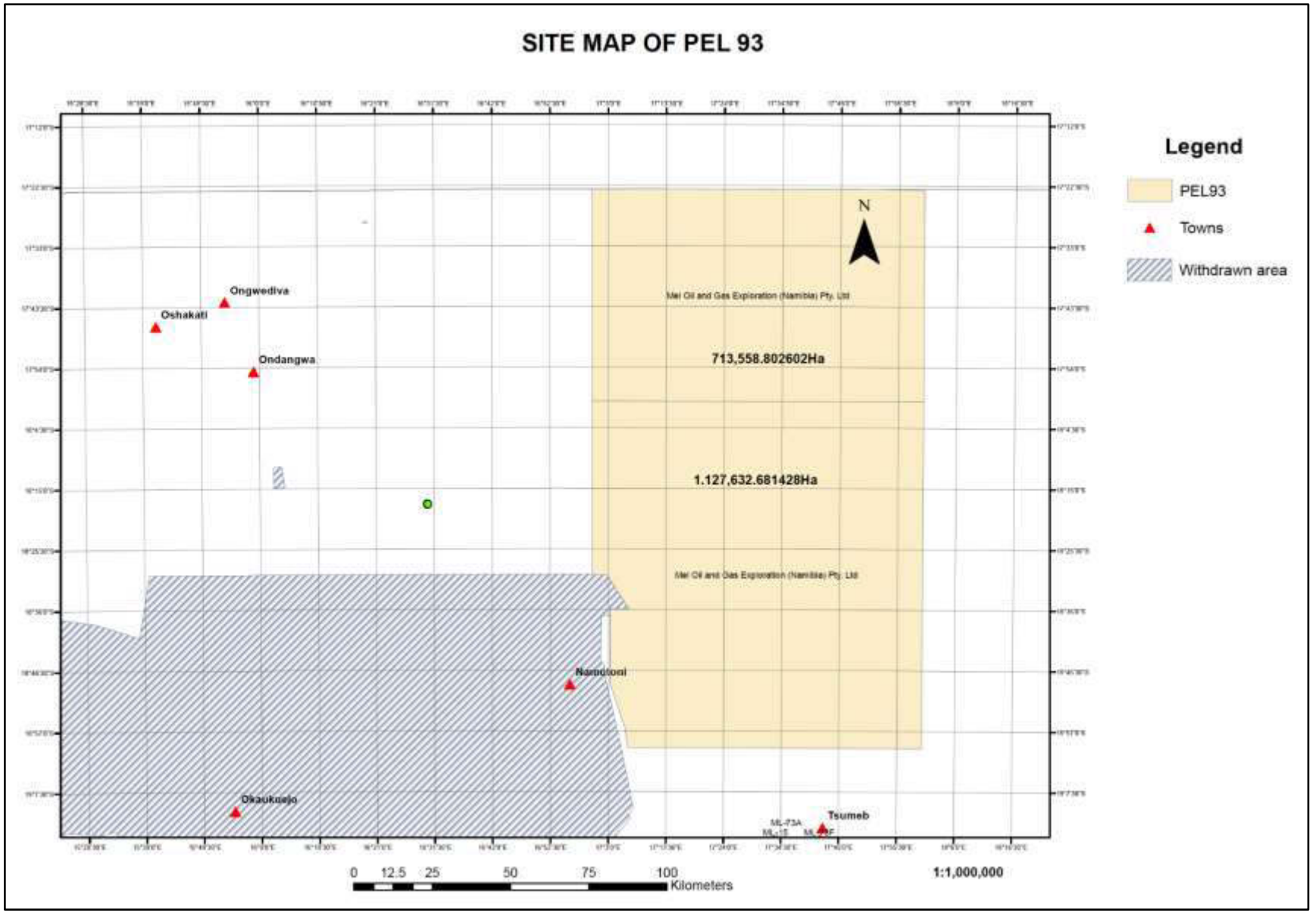

Figure 1: A locality map of PEL 93. Map Credit: (RCHS, 2022).

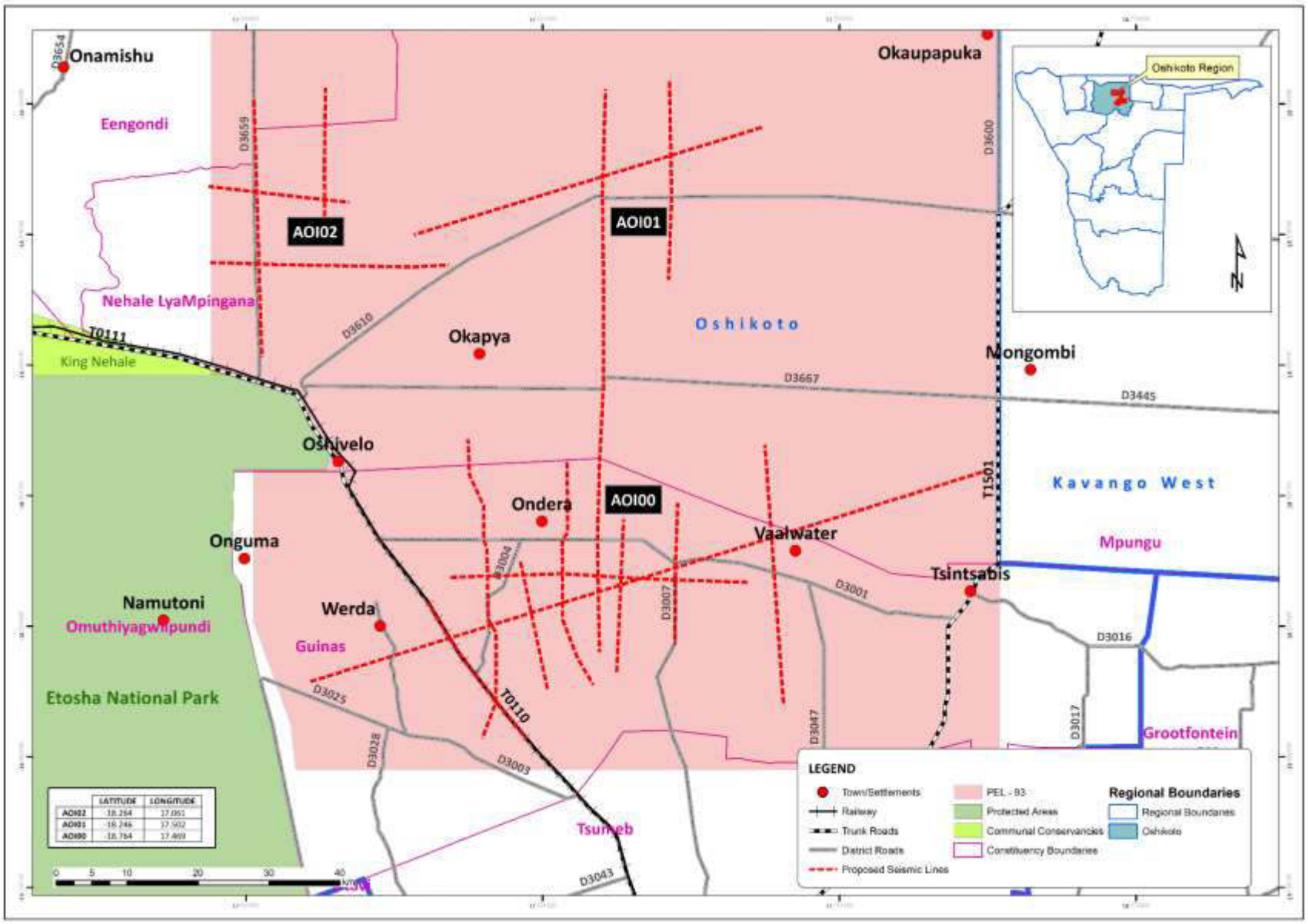

Figure 2: A close - up locality map of PEL 93 indicating specific areas (farms & roads) to be impacted by the proposed 2D Seismic lines. Map Credit: (RBS, 2022).

Legislation requirement

In Namibia, the legal instrument for the protection of heritage resources is set out within the National Heritage Act, (No. 27 of 2004). As defined in Part 1 of the Act, 'heritage resources' implies places and objects of archaeological, palaeontological and rare geological objects including meteorites, cultural, historical, anthropological, ethnographical, scientific and social significance or "any remains of human habitation or occupation that are 50 or more years old found on or beneath the surface". The legal protection extends beyond the tangible heritage resources to include "the natural or existing condition or topography of land", as well as the "trees, vegetation or topsoil". Furthermore, the newly developed"Guidelines for Heritage Impact Assessment in Namibia, 2021" have been formulated for the implementation of the National Heritage Act, especially Section 51 (3) which outlines requirements for impact assessment. Here, the aspects of intangible heritage such as sacred sites "places to which oral traditions are attached or which are associated with living heritage, graves and burials, historic settlements and military sites by means of a building, garden or a tree" are considered to be of heritage significance.

Moreover, Part IV of the Act indicates that the Council maintains a register which lists 'significant heritage' places and objects. The register allows new approved entries to be added based on an assessment of their heritage significance and thereafter publication of the sites in the Government Gazette. As a result, Part V applies immediate legal protection to heritage sites added on the register, to prevent disturbance or damage, unless a permit is issued by the Council permitting activities to take place at the site. Before issuing a permit, section 48 empowered Council to grant permits such as might be required in the event of damage to a protected site occurring as an inevitable result of development. However, Council only grants such permits to applicants 'with appropriate professional qualifications or experience, at the applicant's expense, a statement as to the impact the proposed works and activities may have on the place or object to which the application relates and the risk of damage to the place or object'.

Apart from the Heritage Act, Heritage impact assessment in Namibia may also take place under the provisions of the Environmental Management Act, (No. 7 of 2007) which includes man-made features in its definition of the environment as "anthropogenic factors" such as archaeological remains or any other evidence of human activity. The need for Environmental Impact Assessment forms part of the Act, and this requires that "*Namibia's cultural… heritage… must be protected and respected for the benefit of present and future generations*".

In addition to the legislation summarized above, other applicable laws and policies relevant to the protection of heritage resources globally are the international standards and protocols expected to be followed to ensure best practice during development activities. For instance, the Performance Standard 8 of the International Finance Corporation's (IFC) Performance Standards on Environmental and Social Sustainability (2012) addresses both national and World Cultural and Natural Heritage. Therefore, the requirement 7 states "*Where the risk and identification process determines that there is a chance of impacts to cultural heritage, the client will retain competent professionals to assist in the identification and protection of cultural heritage*." The standards apply whether or not the heritage material is protected, and irrespective of whether it may have been previously disturbed. To comply with these standards, a baseline survey and assessment is required. Further, the European Investment Bank's Environmental and Social Handbook (2013) includes cultural heritage impact assessment amongst its list of requirements. The details of this requirement are contained within Section 5 which specifies the scope of impact assessment for Cultural Heritage as "*screening for risks… assessing and mitigating the impact" on cultural heritage employing techniques to establish baseline conditions such as "field surveys and expert assessment of the significance of cultural heritage*". Relevant standards for impact assessment in relation to fieldwork and data dissemination, standard methodologies are recommended to follow the Standards and Guidance set within the Chartered Institute for Archaeologists (CIfA) where both field survey and desk based assessments are universally recognized.

Methodology

This HIA assessment applied to both primary and secondary data sources. Desktop research was achieved through available data on historical, ethnographic and archaeological data in the Oshikoto Region. Such data was generated from a series of reports and publications harvested from research and surveys carried out during the course of developmental led infrastructures. These were supplemented by other relevant data from the internal registry of the National Heritage Council. The aerial map was provided by the Geological Survey of Namibia and guided the intensive examination of the general landscape to ascertain the terrains while interviews with affected local communities and farm owners were crucial in identifying possible unknown sensitive heritage resources. Heritage sites located in the course of the field surveys were recorded through field notes, with photographs taken while using a handheld Garmin GPS with an accuracy of +/-2 m horizontally, but with an uncertain accuracy for elevation. No ub-surface heritage features of archaeological and or historical

contexts were recorded and it cannot be assumed that they are not in existence. However, suspected areas with buried heritage resources (according to the local communities) were recorded through a series of interviews. The site's significance and vulnerability rating was assessed according to the 0-5 scale Table 1 & 2 as guided by the National Heritage Council (2021) and the QRS (Kinahan 2012).

Level of significance	Grading	Description
Exceptional/upper higher	5	● Major national heritage resources. ● Rare & outstanding example. ● Containing unique evidence of high regional & national significance.
Considerable high	4	● Very important to the heritage of the region. ● High degree of integrity/ authenticity. ● Multi-component site and objects ● High research potential
Moderate	3	● Contributes to the heritage of the locality and region ● Has some altered or modified elements, not necessarily detracting from the overall significance of the place. ● Forming part of an identifiable local distribution or group. ● Research potential.
Low	2	● Isolated minor find in undisturbed primary context, with diagnostic materials ● Makes some contribution to the heritage of the locality, usually in the combination with similar places or objects
Little	1	● Makes little contribution to the heritage resources of the locality. ● Heritage resources in a disturbed or secondary context, without diagnostic or associated heritage.
Zero/ no significance	0	● Absence of heritage resources ● Highly disturbed or secondary context, without diagnostic or associated heritage

Table 1: Heritage significance rating table with key attributes defined by the (National Heritage Council, 2021).

Vulnerability Rating
0. Not Vulnerable **1.** No threat posed by current or proposed development activities **2.** Low or indirect threat from possible consequences of development (e.g. soil erosion); **3.** Probable threat from inadvertent disturbance due to proximity of development **4.** High likelihood of partial disturbance or destruction due to close proximity of development **5.** Direct and certain threat of major disturbance or total destruction

Table 2: Is the vulnerability rating table with key attributes defined by the (National Heritage Council, 2021).

Environmental setting

The central northern region of Namibia is described as a semi-arid savannah area with a local steppe of subtropical thorn woodland biozone according to (Pitiya and Peter 2021). The summer season is often hot with an average temperature recorded between 32 °C and 38 °C while winter temperatures drop to 10 °C to 16 °C while rainfall ranges from 400-500 mm per year (Mendelsohn, 2003). The Local geology (**Figure 3**) and topography defining PEL 93 area is relatively flat terrain dominated by extensive deposits of Kalahari Group which consist of sands (approx. 70my to recent), calcrete rocks sediment, ridges as well as isolated pockets of higher ground mostly dolomite and limestone rocky outcrops **(Figure 4)**. The area is characterized by a single dominant fluvial system, the Cuvelai drainage, a complex of episodic inland delta streams which feed the Etosha basin from the mid-Kunene during seasonal floods (kinahan 2014 *cf* Mendelsohn et al 2002). The elevation ranges between 1 090 and 1 150 m above sea level. The entire PEL 93 terrain is characterized by brown and reddish Solonetz Soils of medium texture. These medium-textured soils are considered ideal for agriculture, in particular small and large scale crop production which, concentrates mainly on maize, fruits and various vegetables combined with stock farming hence the area is designated as an agro-ecological zone by (De Pauw et al. 1998/99) thus also explaining the denser settlement pattern in form of farmland as shown in figure 2. Traditionally, such agricultural practice was rain-fed but irrigation systems have increased for decades transforming subsistence farming into commercial farming.

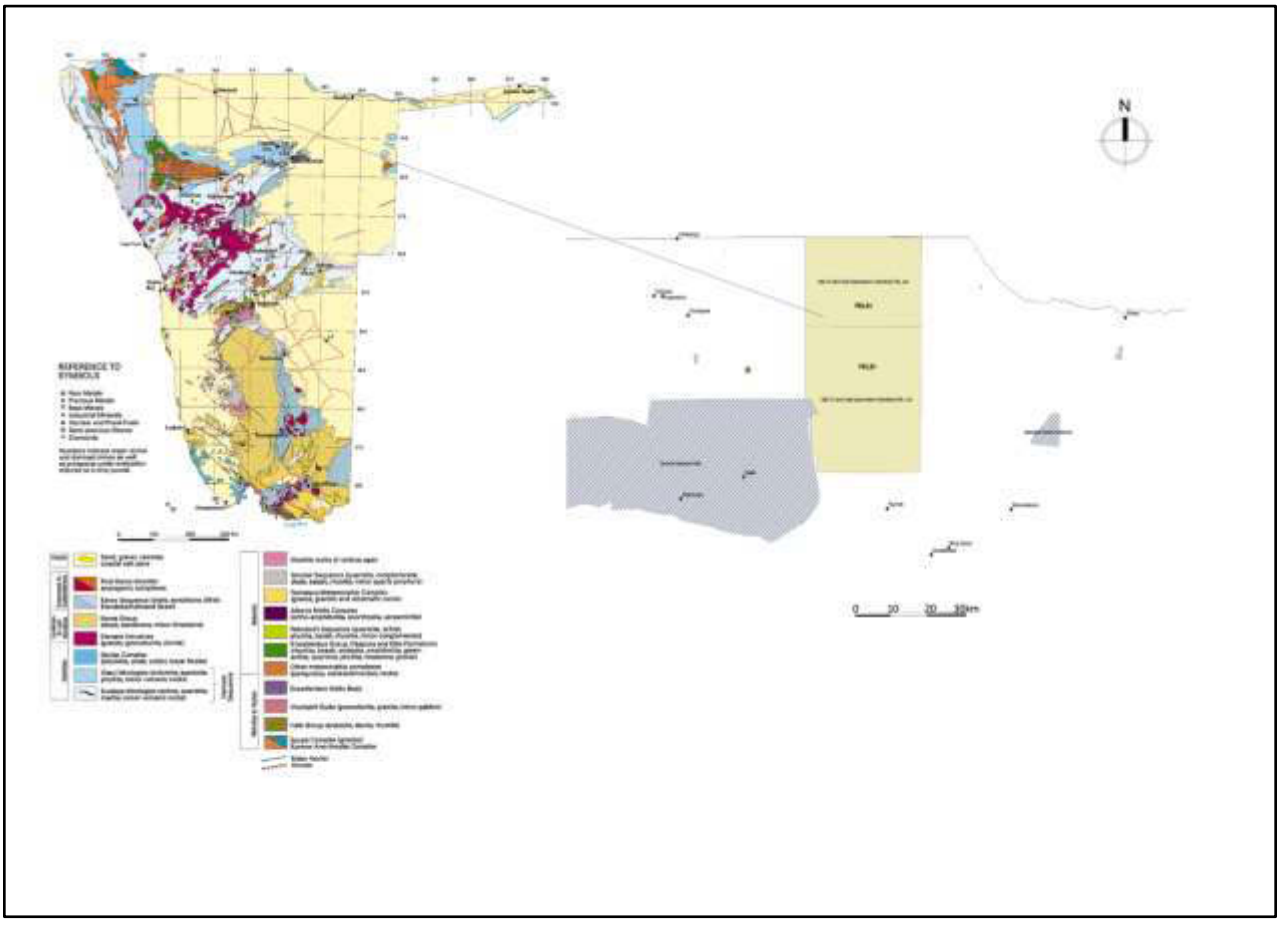

Figure 3: A simplified geological map of Namibia indicating the geology of PEL 93 (right insert). Map Credits: (Geological Survey of Namibia, 2022).

The vegetation unit found on the Kalahari deposits where PEL 93 lies comprised mainly of *Terminalia prunioides woodland* (**Figure 5**) and *Albizia anthelmintica* structures which is essential part of the "Forest Savanna and Woodland (northern Kalahari)" studied by Strohbach (2000) and described by Giess (1971). The trees occurring in this veld type, together with

Lonchocarpus nelsii. Shrubs such as *Acacia mellifera subsp. detinens, Acacia nilotica*, *Croton gratissimus,* Dichrostachys cinerea and *Commiphora glandulosa* etc. While the Saline desert with dwarf shrub fringe and Mopane savanna extend the area.

Figure 4: Limestone deposit on the ground found within Ramona Farm 886. Image Credit: RCHS 2022.

Figure 4: Terminalia prunioides woodlands in relatively good condition at King Kauluma School. Image Credit: (RCHS 2022).

Heritage settings

The central northern Namibia is one of the few areas relatively less investigated archaeologically (Kinahan 2014 *cf.* Kinahan 2011; Williams 1991). As far as this area is concerned, no previous detailed archaeological or cultural heritage studies were undertaken, either within or immediately outside the proposed PEL 93. However, Wallace and Kinahan (2011) have summarized the archaeology and history of this part of Namibia adopted from (SLR report 2019:14) and outlined below:

- Prehistoric (scattered Holocene sites and mid- to late-Pleistocene stone [lithic] assemblages);
- Pre-colonial - tribal community activity in the form of settlement (secular) and ritual sites (burial and symbolic places [landscapes]);
- German colonial (German expansion into the Namibian interior, usually in the form of economic exploitation of the *veld* [cattle ranching] and military activity);
- British South African colonial (a consolidation and extension of previous Colonial rule through economic exploitation of the *veld* and military activity); and
- Modern (Post-1950) – a consolidation of economic resources, mainly through mining and quarrying enterprises and the growth in settlement activity.

The earliest records of human occupation chronologically dating from the Middle Stone Age evidenced by extensive surface scatter of MSA artifacts such as polyhedral cores and utilized flakes (Kinahan 2014) as well as potteries fragments with a likelihood of other archaeological remains in form of burial grounds in or near old settlement in unmarked graves, sacred sites, ruins suspected near the alignment ends on north bank of Omuramba Owambo near Oshivelo where a large population of Hai||Om lives today in the Mangetti West area populated mainly by //Khausis San (**Figure 5**). This was confirmed through interviews conducted among the larger settlements of San communities in Hedwigslust Farm 307 (Ombili Foundation) and Tsintsabis settlement. There is no physical evidence to establish when the present day San tribes populated this area but oral records indicate that they have lived in at least parts of this area of Namibia for at least 500 years (Kinahan 2014). Physical archaeological evidence of these communities remains difficult to locate because of increased traditional settlements by different ethnic groups, changes in land use system and varieties of cultural practices which will likely prevent the archaeological preservation attributed to Hunter Gatherers.

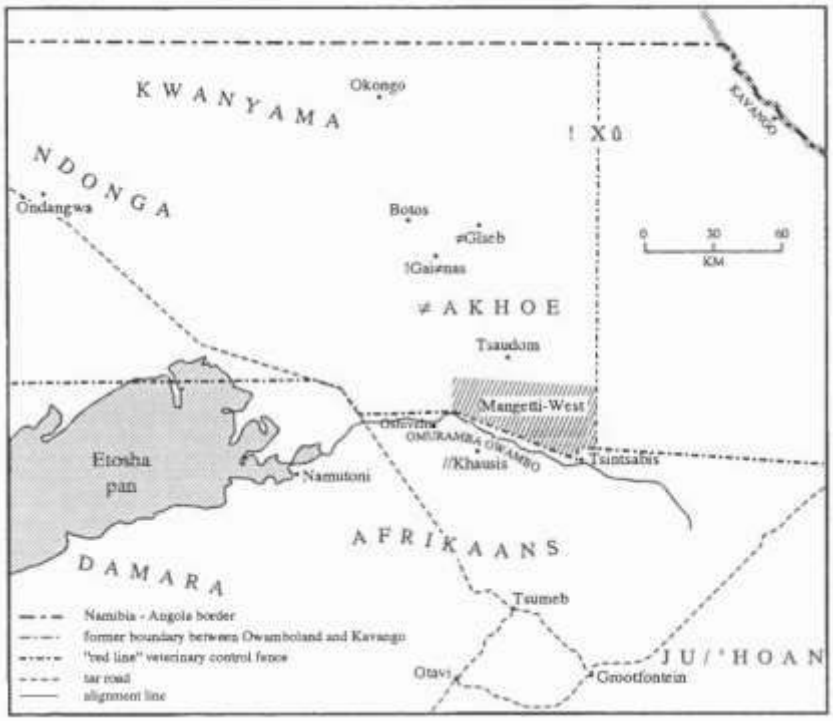

Figure 5: An edited map of Central Northern Namibia indicating the present day occupation of Hunter-Gatherers descendants - San Groups along the alignment line from Tsintsabis to Oshivelo. Image credit: (Wedlock 1994: 24)

On the other hand, archaeologically and historically there is a good possibility that central northern Namibia might contain well preserved records of early farming settlement from the first millennium AD (Kinahan 2014). The detailed assessment will provide opportunities to investigate the potential archaeological and cultural heritage resources that remain as yet undiscovered. For instance, the exploitation of copper ores in the vicinity of Tsumeb area is believed to have started during both prehistoric and historic times and was traded and smelted further afield, by the Aawambo, OvaHerero and Damara tribes. Only one location has been discovered to date is OSHI 64 (**Table 3**) while many remain unknown. Nonetheless, this desktop assessment has located a number of cultural heritage sites generated from available registers held by the Heritage Council of Namibia and museum records for the Oshikoto region (see Silvester and Akawa 2010) . Some sites are declared with others proposed for future declaration. It should be noted that none of these declared sites are present within PEL 93 area nor its proposed location for 2D Seismic survey, however, the listed national heritage sites are within a ±40km radius of PEL 93 area (**Table 3**). Equally, declared sites within Tsumeb have been purposefully not included in this table.

Number	Site name	GPS Coordinates	Description	Vulnerability
142	Lake Otjikoto	19°11'42.35"S / 17°32'59.27"E	Repository of WWI ammunition by German Forces & Sacred site for pre-colonial population.	No, site located over 30km from PEL 93
013/1951	Baobab Tree (No. 1063)	18°53'10.54"S/ 18°19'37.84"E	Sacred site associated with San tradition.	No, site located over 50km from PEL 93
OSHI 64	Ndonga Trading Tree	19°1'44.53" S 17°33'02.90" E	Ndonga traders would walk a distance of around 280km to Otjikoto Lake and then light a fire next to the tree to inform the Hai//kom of their arrival. They would then trade for copper ore and ostrich eggs. The copper ore would be smelted near the tree (as it was heavy to carry) and copper rods produced. Thick ones that would be used to	No, site located 18km from PEL 93

			make anklets and more narrow ones for arrow and spearheads cast. The rods would then be carried back to Ondonga in baskets.	
OSHI 057	Lake Guinas	19°13'58.25"S/ 17°21'9.61"E	Natural Site	No, site located over 30km from PEL 93
OSHI 2	Onyayia	18°21'52"S/ 16°35'44"E	Area inhabited by San Communities who worked as messengers for Ndonga King.	No, site located 40km from PEL 93
OSHI 15 /1950	Namutoni Fort	18°48'34.29"S/ 16°56'24.52"E	Fort Namutoni presents a romantic image of German colonial power, even though this is not the original fort that was involved in the Battle of Namutoni in January, 1904 (which was abandoned by the Germans and then destroyed by the Ndonga forces).	No, site located 18km from PEL 93

Table 3: List of registered and known heritage sites within ±40km radius of PEL 93 area.

The following list of highly potential archaeological sites were identified using Google Earth remote survey carried out in areas North of Veterinary Fence within Oshivelo as a result of archaeological assessment carried out in relation to the proposed Nampower Encroacher Bush Biomass Power Plant by SLR Environmental Consulting Namibia (SLR 2019). All these sites are located within the PEL 93 area and in vicinity of the proposed location for Seismic survey (**Table 4**).

Site No	GPS Coordinates	Name	Description	Geology	Vulnerability	Recommendation
1	18°37'2.24"S 17°38'11.50"E	Old Farm/Settlement	Porous aquifer in Kalahari sandveld	Quaternary and Tertiary periods	7km from 2D Seismic Line	Detailed assessment required
2	18°36'54.04"S17°37'55.98"E	Lines of trees	Porous aquifer in Kalahari sandveld	Quaternary and Tertiary periods	7km from 2D Seismic Line	Detailed assessment required
3	18°37'54.53"S 17°23'42.05"E	Old Farm / Settlement	Porous aquifer in Kalahari sandveld	Quaternary and Tertiary periods	6km from 2D Seismic Line	Detailed assessment required
4	18°34'7.25"S/17°12'29.71"E	Old Settlement	Porous aquifer in Kalahari sandveld	Triassic	12km from 2D Seismic Line	Detailed assessment required
5	18°32'12.08"S/17°14'18.27"E	Old Settlement	Porous aquifer in Kalahari sandveld	Triassic	10km from 2D Seismic Line	Detailed assessment required
6	18°34'28.54"S/ 17°18'20.75"E	Old Settlement	Porous aquifer in Kalahari sandveld	Quaternary and Tertiary periods	10km from 2D Seismic Line	Detailed assessment required (No-Go)
7	18°31'57.29"S/17°14'30.88"E	Old Settlement	Porous aquifer in Kalahari sandveld	Quaternary and Tertiary periods	10km from 2D Seismic Line	Detailed assessment required (No-Go)
8	18°30'58.80"S/17° 9'0.54"E	Old Settlement	Porous aquifer in Kalahari sandveld	Triassic	9km from 2D Seismic Line	Detailed assessment required (No-Go)
9	18°29'29.91"S/17°13'38.09"E	Old Settlement	Porous aquifer in Kalahari sandveld	Triassic	14km from 2D Seismic Line	Detailed assessment required
10	18°28'25.11"S/17°17'15.43"E	Old Settlement	Porous aquifer in Kalahari sandveld	Quaternary and Tertiary periods	12km from 2D Seismic Line	Detailed assessment required
11	18°29'55.89"S/ 17°15'31.10"E	Old Settlement	Porous aquifer in Kalahari sandveld	Quaternary and Tertiary periods	11km from 2D Seismic Line	Detailed assessment required
12	18°30'5.83"S/17°25'2.95"E	Old Settlement	Porous aquifer in Kalahari sandveld	Quaternary and Tertiary periods	7km from 2D Seismic Line	Detailed assessment required
13	18°26'51.69"S/17°25'48.29"E	Old Settlement	Porous aquifer in Kalahari sandveld	Quaternary and Tertiary periods	7km from 2D Seismic Line	Detailed assessment required

Table 4: List of potential archaeological sites registered in surrounding areas of Oshivelo and within the PEL 93 area ±14km radius of 2D Seismic Survey Line.

In effort to fulfill regulation of the HIA Guidelines (2021), interviews with some of the affected local communities (at King Kauluma, Ombili Foundation, Farm Owners and San Communities at Tsintsabis settlement) especially in vicinity to the proposed 2D Seismic survey Lines was conducted during the site visits (**Figure 6A-6E**). The contact details and filled interview forms are available upon request. The use of ethnographic research is an important element in understanding historic landscapes of this area given the fact that the area is less investigated. Based on available data, the San ethnic communities that lived in this area over the last 500 years are still quite dispersed across the landscape and therefore it will be a challenge to predict the likelihood of the potential sites without primary data from the ethno-archaeological assessment. Furthermore, given the long and complex colonial history of Namibia, when the Apartheid South African occupied Namibia which translated to the war of resistance, a number of former South African Defense Force (SADF) army bases, camps and training areas were located within PEL 93 (**Table 5** and **Figure 7**). The following table therefore highlights some of the identified sensitive heritage localities within 1km of the proposed 2D Seismic Survey and within PEL 93. The typology of these resources is both ethnographical and historical.

GPS Coordinates	Name /Area	Description	Recommendation
18°30'38.11"S 17° 4'27.65"E	King Kauluma village	The site was founded in 1990 shortly after independence after the King of Ondonga, King Immanuel Kauluma gave farm land to the Namibian returnee who initially based at the former army base used by SADF soldiers. Due to unemployment the site became small projects to help returnees who had a bakery and a small designated agriculture (Field Crop).	Highly sensitive No Go/ Avoid
18°29'59.14"S 17° 3'55.00"E	King Kauluma Cemetery	Burial ground for Namibian heroes and heroines	Highly sensitive No Go/ Avoid
18°29'20.67"S 17° 3'51.01"E	King Kauluma School	Former South West Africa Territorial Force (SWATF) Military Base. The entire area is still suspected to have unexploded ammunition including those recently de-mined in the school. Otherwise, further de-mining exercise is required. The area might also have buried historical ammunition including graves.	Highly sensitive and dangerous No Go/ Avoid Detailed Assessment
18°12'7.32"S 17° 8'32.09"E Or 18°11'60.00"S 17°12'60.00"E	Akazulu / Akadhulu	Sacred site / intermittent stream	Highly sensitive No Go/ Avoid
18°46'11.25"S 17°57'59.37"E	Tsintsabis Settlement	Former South West Africa Territorial Force (SWATF) Military Base. The entire settlement is still suspected to have unexploded ammunition including those recently de-mined. The settlement (30km radius) is also suspected to have burial grounds and old settlements for the San people.	Highly sensitive No Go/ Avoid Detailed Assessment
18.643720"S 17.177336"E	Alignment of Omuramba/ Owambo banks between Oshivelo and Tsintsabis	Likelihood of archaeological remains in form of burial grounds in or near old settlement in unmarked graves, sacred sites, ruins where a large population of Hai||om lives today and near Mangetti West area populated mainly by //Khausis San	Highly sensitive Detailed Assessment

Table 5: Present heritage sites/areas within 1km radius of the proposed 2D Seismic Survey Lines

Figure 6A: Interviews with local communities at King Kauluma village and School in close proximity to the propose987 8cgd 2D Seismic Survey Lines. Image credits (RCHS, 2022).

Figure 6B: Remnants of the Former South West Africa Territorial Force (SWATF) Military Base at King Kauluma School as well as a burial ground. Image credits (RCHS, 2022)

Figure 6C: Interviews with local communities at Ombili Foundation close proximity to the 2D Seismic Lines. Image credits (RCHS, 2022).

Figure 6D: Interviews with local communities at affected farms in close proximity to the proposed 2D Seismic Lines. Image credits (RCHS, 2022).

Figure 6E: Interviews with local communities at affected farms in close proximity to the proposed 2D Seismic Lines. Image credits (RCHS, 2022).

Figure 7: Present T1501 beacon near Tsintsabis settlement where 2D Seismic Survey Line begins. Image credit: (RCHS, 2022)

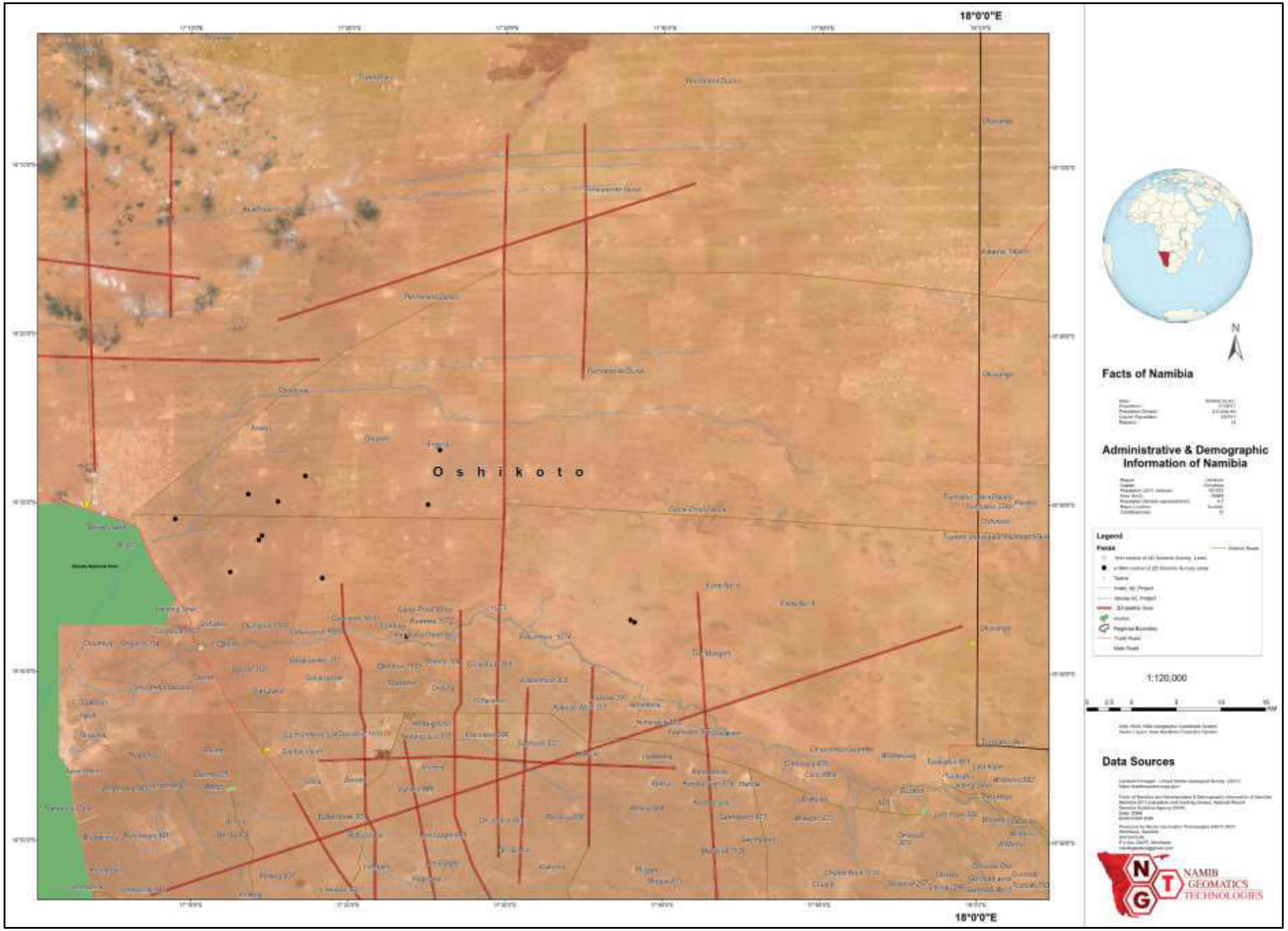

Figure 8: The distribution of sensitive heritage sites within PEL 93 in relation to 2D seismic survey lines. Map Credits: Namib Geomatics Technologies, (2022).

Desktop assessment and impact Interpretation

In effort to establish the nature, significance and vulnerability of heritage resources within the footprints of PEL 93 and in particular 2D Seismic Lines, this assessment has located a substantial number of sensitive sites (listed and tentatively nominated sites) as shown in (Table 3); potential archaeological and historical sites (Table 4) as well as heritage sites/areas within 1km radius of the proposed 2D Seismic Survey Lines (Table 5). All these resources are in situ , with diagnostic historical materials. Such sites of heritage significance both at local and regional level. The archaeological and historical contexts of the sites are consistent with the pattern of human occupation during the last 500 years and expansions of colonial history of Namibia over decades ago.

Direct impacts or risks of impact on archaeological/historical sites located in PEL 93 and in particular 2D Seismic Survey Lines can be reduced to acceptable levels by the adoption of appropriate mitigation measures including integration of the archaeological heritage record and Chance Finds procedure in the project EMP. Special effort should be made to avoid impacts on sites in Table 5 by avoiding some of these areas as far as possible. Detailed research is therefore required for these sites. The key impacts of the 2D Seismic Survey Lines project on the archaeological and historical heritage will be physical disturbance or destruction of sites or remains within or close to the designated footprint of the proposed 2D Seismic Survey Lines, its associated surface works, and disruption of the landscape setting or physical context of the sites or remains. Such impacts will be both local, in the sense of the specific site, and at the landscape level. The Former South West Africa Territorial Force (SWATF) Military Bases at King Kauluma School and at Tsintsabis will likely have buried unexploded ammunition including human remains and or graves. It's therefore recommended de-mining exercise is carried if any surface is to bw disturbed.

Mitigation measures

Following established best practice standards as well as the Namibian legislation and the IFC Standards and Guidance Notes 8, mitigation of archaeological heritage impacts during the powerline construction should include:

01. Detailed ethno-archaeological and historical assessment of sites in Table 4 and 5 (also Figure 8) within the PEL 93;
02. Integration of the archaeological heritage data presented here with the project EMP;
03. Adoption of the archaeological Chance Find Procedure as part of the project EMP;
04. Carrying out a de-mining exercise at King Kauluma School and Tsintsabis Settlement with involvement of the Namibian Police Explosive unit in Oshikoto Region; and or
05. If possible, reroute the 2D Seismic Survey Line to avoid King Kauluma former SWATF Military Base and Tsintsabis Settlement with a minimum of 2km radius.

Recommendation

On the basis of this assessment it is concluded that the PEL 93 will have will have a Moderate to High heritage impact in the event mitigation measures are not implemented.Therefore:

1. Given that detailed documentation has already been carried out on the small number of heritage sites in Table 3, these sites should be regarded as "No Go Zone" as the they are registered in the Internal Database of the National Heritage Council;
2. Potential archaeological and historical sites in **Table 4 and 5** as well as **Figure 8** require further detailed assessment therefore, these sites may not be disturbed or destroyed;
3. In fulfillment of the Heritage Permit, this report must be submitted to the Authority in accordance with the provisions of National Heritage Act (27 of 2004) to ensure that a Consent is obtained to allow a detailed assessment required to some areas within PEL 93 before the exploration is to proceed.

Recommended archaeological Chance Finds Procedure

The "chance finds' ' procedure covers the actions to be taken from the discovery of a heritage site or item, to its investigation and assessment by a trained archaeologist or other appropriately qualified person. The "chance finds"

procedure is intended to ensure compliance with the relevant provisions of the National Heritage Act (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". The procedure of reporting set out below must be observed so that heritage remains reported to the NHC are correctly identified in the field (Kinahan 2012).

RESPONSIBILITIES

Operator:	To exercise due caution if archaeological remains are found
Foreman:	To secure site and advise management timeously
Superintendent :	To determine safe working boundary and request inspection
Archaeologist	To inspect, identify, advise management, and recover remains

PROCEDURE

Action by person identifying archaeological or heritage material:

- If operating machinery or equipment stop work
- Identify the site with flag tape
- Determine GPS position if possible
- Report findings to foreman Action by foreman a) Report findings, site location and actions taken to superintendent b) Cease any works in immediate vicinity Action by superintendent a) Visit site and determine whether work can proceed without damage to findings

Action by foreman

(a) Report findings, site location and actions taken to superintendent;
(b) Cease any works in immediate vicinity Action by superintendent;
(c) Visit site and determine whether work can proceed without damage to findings;
(d) Determine and mark exclusion boundary;
(e) Site location and details to be added to GIS for field confirmation by archaeologist

Action by archaeologis:t

(a) nspect site and confirm addition to GIS;
(b) Advise NHC and request written permission to remove findings from work area;
(c) Recovery, packaging and labeling of findings for transfer to National Museum

In the event of discovering human remains

(a) Actions as above
(b) Field inspection by archaeologist to confirm that remains are human
(c) Advise and liaise with NHC and Police
(d) Recovery of remains and removal to National Museum or National Forensic Laboratory, as directed.

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