

Reconnaissance Energy Namibia (Pty) Ltd

Draft Environmental Scoping Report to Support the
Application for Environmental Clearance Certificate
(ECC) for the Proposed 2D Seismic Survey covering the
Areas of Interest (AOI) in Petroleum Exploration License
(PEL) No. 73, Kavango Basin,
Kavango West and East Regions, Northern Namibia



January 2021

PROPONENT ADDRESS

c/o Pioneer Oil and Gas Consulting
City View Building Unit 13. Cnr of Pasteur
and Freud Street
P.O. Box 2393
WINDHOEK, NAMIBIA

ENVIRONMENTAL CONSULTANT ADDRESS

41 Feld Street Ausspannplatz
Cnr of Lazarett and Feld Street
P. O. BOX 1839
WINDHOEK, NAMIBIA

OPERATOR

Reconnaissance Energy Namibia (Pty) Ltd Subsidiary of
Reconnaissance Energy Africa Ltd (ReconAfrica)

LICENSE PEL 73

Blocks 1719, 1720, 1721, 1819, 1820 and 1821

WORKING INTERESTS

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

TYPE OF PETROLEUM EXPLORATION OPERATIONS

2D Seismic Survey Operations

PROPONENT NAMIBIAN ADDRESS

c/o Pioneer Oil and Gas Consulting
City View Building Unit 13
Corner of Pasteur and Freud Street
WINDHOEK, NAMIBIA
admin@recon africa.com

PROPONENT OVERSEAS ADDRESS

Berkeley Square House, Berkeley Square
London UK W1J 6BD
UNITED KINGDOM

ENVIRONMENTAL CONSULTANTS

Risk-Based Solutions (RBS) CC
Cnr of Lazarett and Feld Street
P. O. Box 1839, **WINDHOEK, NAMIBIA**
Tel: +264 - 61- 306058; **FaxMail:** +264-886561821
Mobile: +264-811413229 /812772546; **Email:** smwiya@rbs.com.na
Global Office / URL: www.rbs.com.na

ENVIRONMENTAL ASSESSMENT PRACTITIONER (EAP)

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

CITATION: *Risk-Based Solutions (RBS), 2021. Draft Environmental Scoping Report, Report to Support the Application for Environmental Clearance Certificate (ECC) for the Proposed 2D Seismic Survey covering the Area of Interest (AOI) in Petroleum Exploration License (PEL) No. 73, Kavango Basin, Kavango West and East Regions, Northern Namibia.*

STATEMENT OF QUALIFICATIONS OF THE ENVIRONMENTAL ASSESSMENT PRACTITIONER (EAP) – DR SINDILA MWIYA

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

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

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

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

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

Namibia, Windhoek, January 2021

Content List

NON-TECHNICAL SUMMARY	XI
1. PROJECT BACKGROUND.....	- 1 -
1.1 INTRODUCTION	- 1 -
1.2 RECONAFRICA WORK COMMITMENT AND OBLIGATIONS FOR PEL 73	- 4 -
1.2.1 Initial Exploration Period (4 years)	- 4 -
1.2.2 First Renewal Exploration Period	- 4 -
1.2.3 Second Renewal Exploration Period	- 4 -
1.2.4 Production License	- 4 -
1.3 CURRENT EXPLORATION STATUS, MOTIVATION AND PURPOSE	- 4 -
1.3.1 Current Exploration Status.....	- 4 -
1.3.2 2D Seismic Survey Influences on the Local Communities	- 5 -
1.3.3 Current Project Motivation	- 5 -
1.3.4 Purpose of this Scoping Report	- 6 -
1.4 PROJECT LOCATION.....	- 7 -
1.4.1 License Area (PEL), Exploration Areas of Interest and Oil or Gas Field.....	- 7 -
1.4.2 PEL 73 License Area	- 7 -
1.4.3 The Area of Interest (AOI) Within PEL 73.....	- 7 -
1.4.4 Location of the Proposed 2D Seismic Survey Lines.....	- 8 -
1.4.5 Accessibility.....	- 9 -
1.5 ONSHORE PETROLEUM EXPLORATION HISTORY	- 38 -
1.5.1 Overview of Onshore Petroleum Exploration History	- 38 -
1.5.2 History of Petroleum Exploration in Northern Onshore Namibia	- 38 -
1.5.3 Future Opportunities for Petroleum Exploration in Northern Onshore Namibia	- 39 -
2. PROPOSED PROJECT SUMMARY	- 44 -
2.1 ORIGIN OF PETROLEUM AND PETROLEUM EXPLORATION	- 44 -
2.2 UNDERSTANDING PETROLEUM (OIL AND GAS) EXPLORATION.....	- 46 -
2.3 PROPOSED 2D GROUND SEISMIC SURVEY AS AN EXPLORATION METHOD	- 48 -
2.3.1 Basic Principles of 2D Ground Seismic Survey.....	- 48 -
2.3.2 Vibroseis, Dynamite or Explorer 860 Seismic Operations	- 48 -
2.3.2.1 The Use of Dynamite as an Energy Source.....	- 48 -
2.3.2.2 The Use of Vibroseis as an Energy Source	- 49 -
2.3.2.3 The Use of the Explorer 860 as an Energy Source.....	- 49 -
2.3.3 Proposed 2D Seismic Survey Design, Layout and Implementation	- 51 -
2.3.3.1 Proposed Survey Design and Layout.....	- 51 -
2.3.3.2 Proposed 2D Ground Survey Implementation Stages	- 51 -
2.3.4 Description of Proposed Data Acquisition Process	- 52 -
2.3.5 Recording / Geophones.....	- 54 -
2.3.6 Data Processing and Interpretation	- 55 -
2.4 LOGISTICS AND RESOURCES	- 56 -
2.4.1 Overview	- 56 -
2.4.2 Fly Camp Site.....	- 56 -
2.4.3 Lines Widening / Clearing.....	- 57 -
2.5 VIBRATION, NOISE AND DUST	- 57 -
2.5.1 Variations	- 57 -
2.5.2 Noise and Dust	- 57 -
2.6 HEALTH, SAFETY AND ENVIRONMENT	- 57 -
2.6.1 Operational Manuals and Policies	- 57 -
3. LEGISLATIVE FRAMEWORK	- 59 -
3.1 OVERVIEW	- 59 -
3.2 KEY APPLICABLE LEGISLATION	- 59 -
3.2.1 Petroleum (Exploration and Production) Legislation	- 59 -
3.2.2 Processing of Applying for a PEL and the Petroleum Agreement (PA)	- 60 -
3.2.4 Key Important Clauses of a Petroleum Agreement	- 61 -
3.2.4.1 Overview.....	- 61 -
3.2.4.2 Petroleum Agreement Environmental Protection Clause 11	- 62 -
3.3 OTHER KEY APPLICABLE LEGISLATION.....	- 66 -
3.3.1 Environmental Management Legislation	- 66 -
3.3.2 Communal Land Rights	- 66 -
3.3.3 Water Legislation.....	- 67 -
3.3.4 Atmospheric Pollution Prevention Legislation	- 67 -

3.3.5	<i>Labour, Health and Safety Legislations</i>	- 67 -
3.3.6	<i>Coronavirus (COVID-19) Pandemic, Emergencies and Health Restrictions</i>	- 67 -
3.3.7	<i>Summary of Applicable National Legislations</i>	- 68 -
3.4	REGULATORY AGENCIES AND PERMITS REGISTER.....	- 68 -
3.4.1	<i>Key Regulatory Permits and Agencies</i>	- 68 -
3.5	INTERNATIONAL STANDARDS, TREATIES AND PROTOCOLS	- 72 -
3.5.1	<i>Applicable International Standards</i>	- 72 -
3.5.2	<i>International and Regional Treaties and Protocols</i>	- 73 -
3.5	RECOMMENDATIONS ON REGULATORY FRAMEWORK	- 74 -
4.	RECEIVING ENVIRONMENT	- 75 -
4.1	PHYSICAL GEOGRAPHY	- 75 -
4.2	CLIMATE AND LAND USE	- 75 -
4.2.1	<i>Climatic Components</i>	- 75 -
4.2.2	<i>Land Use</i>	- 75 -
4.3	FAUNA AND FLORA DIVERSITY	- 76 -
4.3.1	<i>Overview</i>	- 76 -
4.3.2	<i>Important Fauna and Flora Species</i>	- 78 -
4.3.2.1	Reptiles.....	- 78 -
4.3.2.2	Amphibians	- 78 -
4.3.2.3	Mammals	- 78 -
4.3.2.4	Birds.....	- 78 -
4.3.2.5	Trees and Shrubs	- 78 -
4.3.2.6	Grass	- 78 -
4.4	SOCIOECONOMIC SETTINGS	- 79 -
4.4.1	<i>Kavango West and East Regions</i>	- 79 -
4.5	SUBSURFACE GROUND COMPONENTS	- 80 -
4.5.1	<i>Regional Geology and Petroleum System</i>	- 80 -
4.5.2	<i>Water Resources</i>	- 83 -
4.5.2.1	Surface Water	- 83 -
4.5.2.2	Hydrogeology.....	- 85 -
4.5.2.3	Water and Environment	- 87 -
4.6	ARCHAEOLOGY	- 88 -
4.6.1	Overview of Archaeological Resources in PEL 73.....	- 88 -
4.7.2	<i>Archaeological Baseline Findings</i>	- 88 -
4.7	STAKEHOLDER CONSULTATIONS AND ENGAGEMENT	- 91 -
4.7.1	<i>Overview</i>	- 91 -
4.7.2	<i>Stakeholders Consultation Process to be Undertaken</i>	- 91 -
5.	EIA AND EMP TERMS OF REFERENCE (TOR)	- 93 -
5.1	TERMS OF REFERENCE (TOR) OVERVIEW.....	- 93 -
5.2	SUMMARY OF EIA APPROACH AND METHODOLOGY	- 93 -
5.2.1	<i>Overview of the EIA Methodology</i>	- 93 -
5.2.2	<i>Summary of the Environmental Assessment Process and Steps</i>	- 94 -
5.2.3	<i>Assumptions and Limitations</i>	- 95 -
5.3	EIA AND EMP OBJECTIVES, ASSUMPTIONS, ALTERNATIVES AND RECEPTORS	- 98 -
5.3.2	<i>Proposed Project Alternatives and Ecosystem Assessments</i>	- 98 -
5.4	SUMMARY OF THE LIKELY POSITIVE AND NEGATIVE IMPACTS	- 100 -
5.4.1	<i>Summary of Likely Positive Impacts</i>	- 100 -
5.4.2	<i>Summary of Receptors Likely to be Negative Impacted</i>	- 100 -
5.4.2.1	Vibration, Noise and Dust (Air Quality)	- 100 -
5.4.2.2	Fauna and Flora Receptors	- 101 -
5.4.2.3	Protection of Water Resources	- 101 -
5.4.2.4	Archaeology	- 102 -
5.4.2.5	Socioeconomic Components	- 103 -
5.4.2.6	Waste Management.....	- 103 -
5.4.3	<i>Stakeholder Consultation Process</i>	- 103 -
5.4.3.1	List of Potential Stakeholders	- 103 -
5.4.3.2	Selection of the Appropriate Consultation Method.....	- 104 -
5.4.3.3	Stakeholder Engagement Schedule	- 106 -
5.4.3.4	EIA and EMP Public and Stakeholder Consultation Meetings Schedule	- 106 -
5.5	PROPOSED EIA ASSESSMENT OF LIKELY IMPACTS	- 106 -
5.5.1	<i>Severity Criteria for Environmental Impacts</i>	- 106 -
5.5.2	<i>Likelihood (Probability) of Occurrence</i>	- 107 -
5.5.3	<i>Impact Assessment Process</i>	- 108 -
5.5.3.1	Overview	- 108 -
5.5.3.2	Evaluation of Project Activities Impacts	- 108 -

5.5.4	<i>Assessment of the Overall Significant Impacts</i>	- 110 -
5.5.4.1	Overview.....	- 110 -
5.5.4.2	Summary of the Sources of Impacts.....	- 110 -
5.5.4.3	Determination of the Overall Likely Significant Impacts	- 110 -
5.6	EIA AND EMP REPORTING.....	- 112 -
5.6.1	Overview	- 112 -
5.6.2	EIA Reporting.....	- 112 -
5.6.3	EMP Reporting.....	- 112 -
5.6.3.2	Hierarchy of Mitigation Measures Implementation	- 113 -
7.	BIBLIOGRAPHY	- 117 -

List of Figures

Figure 1.1:	Hydrocarbon Map of Namibia.....	- 2 -
Figure 1.2:	Regional location of PEL No. 73 covering Blocks 1719, 1720, 1721, 1819, 1820 and 1821.....	- 3 -
Figure 1.3:	Size and exploration footprint illustration 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.	- 8 -
Figure 1.4:	Regional location of PEL 73, key exploration Areas of Interest (AOI) and proposed 2D seismic survey lines.	- 10 -
Figure 1.5:	Detailed location of the proposed 2D seismic survey lines and key exploration Area of Interest within PEL 73. All the survey line are located on existing roads and tracks.....	- 11 -
Figure 1.6:	Detailed location of the proposed 2D seismic survey lines with respect to various other land uses and community forestry. Roads and tracks exist through the community forestry and no new cut line will be initiated.....	- 12 -
Figure 1.7:	Field-based verified existing access road roads and tracks to be used for the proposed survey lines.	- 13 -
Figure 1.8:	Digital elevation model of Owambo (Etosha) Basin showing the historical magnetic/gravity survey boundaries, seismic grid, and well locations.....	- 40 -
Figure 1.9:	Overview of the existing geophysical Government data coverage over Namibia.....	- 41 -
Figure 1.10:	Historical seismic survey in the general area showing the location of the recent, 2018, 2D seismic survey that was conducted by CGG using Vibroseis trucks on behalf of the license holder Acrep covering PEL 72 situated west of PEL 73. With the permitting and monitoring support by Risk-Based Solutions team, the ground seismic survey was conducted successfully with the participation of the local communities along the survey lines and witnessed in the field by the Hon. Governor of the Kavango West Region, Councillors, and traditional authorities. Similar field-based organisation arrangements will be adopted for the proposed 2D seismic survey in PEL 73 by ReconAfrica.....	- 42 -
Figure 2.1:	Illustration on how oil and gas are formed over millions of years.....	- 45 -
Figure 2.2:	Illustration of the 2D ground seismic survey operation to be undertaken in PEL No. 73 along the proposed lines using the Explorer 860 as the energy sources with wireless receivers.....	- 48 -
Figure 2.3:	Specifications of the Explorer 860 to be used as the energy source for proposed 2D seismic survey operations in PEL 73	- 53 -
Figure 4.1:	Regional climatic settings of the project area, PEL 73.....	- 76 -
Figure 4.2:	Lateral extent of Kalahari Group sediments	- 82 -
Figure 4.3:	3D model representation of PEL 73 and the Kavango Basin based on the interpretation and integration of the geophysical, structural and geological data sets.	- 83 -
Figure 4.4:	Local drainage system of the general area covered by the proposed 2D seismic survey.	- 84 -
Figure 4.5:	Conceptual groundwater flow components around PEL 73.	- 87 -
Figure 4.6:	A group of archaeological sites (red dots, quantities not established) in relation to the proposed 2D seismic survey lines (red lines) to be conducted along existing roads and tracks. The blue lines indicate the Omatako Ephemeral River channels.	- 89 -
Figure 4.7:	Updated copy of the public notice first published in the New Ear dated 7 th January 2021 and to be published in various other newspapers throughout the month of January 2021.....	- 92 -
Figure 5.1:	RBS Schematic presentation of Namibia's Environmental Assessment Procedure.	- 96 -

Figure 5.2:	Copy of the Public Notice published in the New Era Newspaper dated Thursday, 7 th January 2021 marking the 1 st day of the more than 21 days for public consultations for the proposed 2D seismic survey operations.	- 97 -
Figure 5.3:	Regional groundwater vulnerability around the PEL 73	- 102 -
Figure 5.4:	Indicative organisational structure of the Proponent that shall defines the roles, responsibilities, and authority to implement the provisions of the EMP	- 114 -

List of Tables

Table 2.1:	Proposed 2D seismic survey parameters design options.	- 52 -
Table 3.1:	Government agencies with permits responsibilities over the proposed project activities.	- 69 -
Table 3.2:	Summary of the permit register.	- 70 -
Table 3.3:	Comparison of selected guideline values for drinking water quality	- 71 -
Table 3.4:	R553 Regional Standards for Industrial Effluent, in Government Gazette No 217 dated 5 April 1962.	- 72 -
Table 3.5:	Liquid effluent emission levels (MIGA /IFC).	- 73 -
Table 3.6:	Noise emission levels (MIGA /IFC).	- 73 -
Table 4.1:	Conceptual hydrogeology characteristics of the study area.	- 87 -
Table 4.2:	GPS coordinates of the identified archaeological sites reflected in Fig. 4.6.	- 88 -
Table 5.1:	Summary of the proposed activities, alternatives and key issues considered during the Environmental Assessment (EA) process covering EIA.	- 94 -
Table 5.2:	List of potential stakeholder.	- 104 -
Table 5.3:	Assessment of potential appropriate engagement method and associated activities.	- 105 -
Table 5.4:	Scored on a scale from 0 to 5 for impact magnitude.	- 107 -
Table 5.5:	Scored time period over which the impact is expected to last.	- 107 -
Table 5.6:	Scored geographical extent of the induced change.	- 107 -
Table 5.7:	Summary of the qualitative scale of probability categories (in increasing order of likelihood).	- 107 -
Table 5.8:	Impact assessment matrix used for assessing the overall likely impacts that the proposed 2D seismic survey activities on the receiving environment sensitivity (physical, biological, socioeconomic, cultural, and archaeological environments) with respect to duration, geographical extent, and probability occurrence.	- 109 -
Table 5.9:	Assessment matrix used for assessing the likely significant impacts with respect to proposed 2D seismic survey activities on the receiving environment (physical, biological, socioeconomic, cultural, and archaeological environments).	- 111 -

List of Plates

Plate 1.1:	North section of the proposed 2D seismic survey Line NS-1 detailed location shown by a drone aerial view to the south along the D3425 road from Rundu to Ncaute.	- 14 -
Plate 1.2:	Mid-section of the proposed 2D seismic survey Line NS-1 detailed location shown by a drone aerial view to the north along the D3425 road from Rundu to Ncaute.	- 15 -
Plate 1.3:	South section of the proposed 2D seismic survey Line NS-1 detailed location shown by a drone aerial view to the north (towards Ncaute) along the D3425 road south of Ncaute and west of the Omatako Ephemeral River	- 16 -
Plate 1.4:	North section of the proposed 2D seismic survey Line NS-2 detailed location shown by a drone aerial view to the north (towards Dove) along the existing tracks linking Dove to the D3400.	- 17 -

Plate 1.5:	North section of the proposed 2D seismic survey Line NS-2 detailed location shown by a drone aerial view to the south (towards D3400 Road junction) along the existing tracks linking Dove to the D3400.	18 -
Plate 1.6:	Mid-section of the proposed 2D seismic survey Line NS-2 detailed location shown by a drone aerial view to the north along the D3400 Road towards junction with the existing tracks linking Dove to the D3400.....	19 -
Plate 1.7:	Mid-section of the proposed 2D seismic survey Line NS-2 detailed location shown by a drone aerial view to the south along the existing track linked to the D3400.	20 -
Plate 1.8:	North-section of the proposed 2D seismic survey Line NS-3 detailed location shown by a drone aerial view to the south along the existing 4 by 4 sandy track linked to Khaudum National Park and linked to the B8 at Katere junction.	21 -
Plate 1.9:	North-section of the proposed 2D seismic survey Line NS-4 detailed location shown by a drone aerial view to the south along the D3400 linked to the B8.	22 -
Plate 1.10:	North-section of the proposed 2D seismic survey Line NS-5 detailed location shown by a drone aerial view to the south along the new Rundu to Mbambi Roads D3448 and D3468 from the junction to Cuma along the new D3401 Road.....	23 -
Plate 1.11:	North-section of the proposed 2D seismic survey Line NS-5 detailed location shown by a drone ground view to the east showing the new Rundu to Mbambi Roads D3448 and D3468 from the junction to Cuma along the new D3401 Road.	24 -
Plate 1.12:	South-section of the proposed 2D seismic survey Line EW-1 detailed location shown by a drone aerial view to the east along the new D3401 Road from Ncuncuni to Cuma passing through the community forestry.	25 -
Plate 1.13:	Mid -section of the proposed 2D seismic survey Line EW-1 detailed location shown by a drone aerial view at Cuma to the west along the new D3401 Road from Ncuncuni to Cuma passing through the community forestry.	26 -
Plate 1.14:	Eastern -section of the proposed 2D seismic survey Line EW-1 detailed location shown by a drone aerial view to the east at cross cutting with NS-5 at the Rundu to Mbambi Roads D3448 and D3468 from the junction to Cuma along the new D3401 Road.	27 -
Plate 1.15:	West -section of the proposed 2D seismic survey Line EW-2 detailed location shown by a drone aerial view to the east along the D3400 and passing through the community forestry.....	28 -
Plate 1.16:	Mid -section of the proposed 2D seismic survey Line EW-3 detailed location shown by a drone aerial view to the east along the D3400 Road from Kawe.	29 -
Plate 1.17:	Mid -section of the proposed 2D seismic survey Line EW-3 detailed location shown by a drone aerial view to the west along the D3400 Road at Kawe wood processing facility.	30 -
Plate 1.18:	Eastern -section of the proposed 2D seismic survey Line EW-3 detailed location shown by a drone aerial view to the west (towards Kawe and current drilling location 1) along the new D3400 Road.	31 -
Plate 1.19:	Eastern -section of the proposed 2D seismic survey Line EW-4 detailed location shown by a drone aerial view to the east from the B8 Road. The EW-4 survey line run through an existing Community Forestry track to Hamoye along the D3400 Road from Rundu to Ncaute.....	32 -
Plate 1.20:	Mid -section of the proposed 2D seismic survey Line EW-4 detailed location shown by a drone aerial view to the northeast within the middle of the community forestry. The EW-4 survey line run through an existing Community Forestry track to Hamoye along the D3400 Road from Rundu to Ncaute.	33 -
Plate 1.21:	Eastern-section of the proposed 2D seismic survey Line EW-4 detailed location shown by a drone aerial view to the west through the community forestry near Hamoye along the D3400 Road from Rundu to Ncaute.....	34 -

Plate 1.22:	Western-section of the proposed 2D seismic survey Line EW-5 detailed location shown by a drone aerial view to the east along the existing track from the B8 junction to Gcaru through Shivarati.	- 35 -
Plate 1.23:	Western-section of the proposed 2D seismic survey Line EW-5 detailed location shown by a drone aerial view to the east along the existing track from the B8 junction to Gcaru through Shivarati.	- 36 -
Plate 1.24:	Eastern-section of the proposed 2D seismic survey Line EW-5 detailed location shown by a drone aerial view to the west along the existing track from Gcaru to Shivarati.	- 37 -
Plate 2.1:	Size comparative of the Vibroseis truck (top) and Explorer 860 Accelerated Weight Drop (AWD) (bottom)	- 50 -
Plate 2.2:	The STRYDE wireless recording instrumentation is the latest technology to be used for the proposed 2D seismic survey operations.	- 55 -
Plate 2.3:	Exaple of the conaterised field-based data processing facility and supporting services that will be avaiable for the entire durataion of the proposed 2D seismic survey operations.....	- 56 -
Plate 4.1:	Extensive human induced disturbances including agricultural activities all along the Omatako river course that could have resulted in the disturbances of any archaeological resources in the area.	- 90 -

Non-Technical Summary

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

As part of the provisions of the Petroleum Agreement signed between ReconAfrica and the Government of the Republic of Namibia represented by the Ministry of Mines and Energy (MME), ReconAfrica has committed to undertaking petroleum exploration activities in PEL 73. The Petroleum Agreement provides for the initial exploration period (4 years), first and second two (2) years renewal exploration periods subject to possible one-year extension. IN an event of discovery of economic oil and gas reserves, the Company may apply for a 25 year production license, which should be granted within 6 months of the date of application.

Petroleum exploration involves the implementation of multiple exploration steps over many years and each major step requires a separate environmental assessment processes to be conducted as provided for in Environmental Protection Clause 11 of the Petroleum Agreement signed between ReconAfrica and the Government of the Republic of Namibia, Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991), Petroleum Laws Amendment Act, 1998, (Act 24 of 1998), the Environmental Management Act, 2007, (Act No. 7 of 2007) and all other applicable national laws and Regulations subject to the type of exploration activities being undertaken at any given time. In fulfilment of the environmental requirements, ReconAfrica (the Proponent) has appointed Risk-Based Solutions (RBS) CC as the Environmental Consultant and led by Dr Sindila Mwiya as the Environmental Assessment Practitioner (EAP) to undertake the Scoping, Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP) to support the application for Environmental Clearance Certificate (ECC) for the proposed 2D seismic survey operations.

To date ReconAfrica has delineated the Kavango Basin as key exploration Area of Interest (AOI) based on the interpretation of the available Government high resolution aerial geophysical data, regional structural geology, and historical well data from the Etosha Basin. In order to confirm the presence of an active petroleum system and the existing of the Kavango Basin, stratigraphic wells will be drilled to study the geology of the AOI. Following on the drilling of the stratigraphic wells, the company intends to conduct 450 km long of 2D seismic survey operations over the AOI within the Kavango in order to search for hydrocarbon structural reservoirs with the potential for holding hydrocarbon resources. Depending on the outcomes of the proposed 2D seismic survey operations, exploratory drilling operations over the delineated hydrocarbon structural reservoirs may be undertaken over the AOI.

The scope of this environmental assessment only covers the exploration phase and specifically focusing only on the proposed 2D seismic survey operations and has nothing do with the production stages to which no oil or gas has so far been discovered. The Environmental Assessment process for the proposed 2D seismic survey inclusive of this Scoping Report, has taken into consideration the public and stakeholder consultation requirements, sensitivity of the receiving environment (physical, biological, socioeconomic and ecosystem services and functions) with respect to the following operational stages likely to be key sources of impacts associated with the proposed 2D seismic survey:

- (i) Planning and mobilisation (Pre-survey preparation).
- (ii) Camp sites setups and widening of tracks and creation of limited new access as may be applicable.
- (iii) Actual data acquisition, and.
- (iv) Demobilisation (survey completion).

2D seismic survey is an environmentally friendly nonintrusive geophysical method used for mapping or imaging of the subsurface geology. During the seismic survey, the weight drop generated seismic wave which travels into the earth gets reflected by various subsurface formations, and returns to the surface where it is recorded by the receivers called geophones. The resultant product following complex processing is a vertical sonic cross-section of the subsurface beneath the survey line showing the geological materials (de-risked geological sub model) and structures that the acoustic wave has travelled through. This information is used to predict potential areas where oil or gas may be trapped in sufficient quantities for further exploration activities such as drilling of an exploration well.

The proposed survey operations covering the key exploration Areas of Interest (AOI) within PEL 73 will be conducted along existing roads and tracks, using an environmentally friendly, limited footprint and efficient light trucks, the Explorer 860 Accelerated Weight Drop (AWD) energy sources and wireless receivers. The “weight-drop” which generates a thump as it hits the ground is not expected to have any frequency specific interference with the natural receiving environment.

The AOI interests does not fall in an environmental proclaimed protected or sensitive area nor in groundwater protection zone. The key central exploration interests are situated about 55 km south of Rundu, 80 km south of the Okavango River, more than 260 km from the Okavango Delta in Botswana and not related to the Delta whatsoever, more than 40 km from the boundary of the Khaudum National Park and more than 70 km from the Mangetti National Park. The overall general area falls in the sparsely populated but not pristine communal areas of the Ncamangoro and Mashare Constituencies of the Kavango West and East Regions, respectively. Ncamangoro and Mashare Constituencies falls within the boundaries of the Mbunza and Sambyu Traditional Authorities, respectively.

It is estimated that at least 67 species of reptile, 32 amphibian, 116 mammal and 210 bird species (breeding residents) are known to or expected to occur in the general Kavango and West East regions of the proposed project area. It is estimated that at least 107 species of larger trees and shrubs (>1m in height) and up to 111 species of grasses are known to or expected to occur in the general area, none of which are viewed as endemic species. A group of archaeological heritage sites within the general area but not necessary within the AOI are known to exist along the Omatako River basin between Ncaute and Taratara villages and south west of Omatako River basin. These sites will not be impacted by the proposed 2D seismic survey operations neither are they vulnerable nor sensitive.

The land uses in the general area is mainly communal / subsistence farming comprising cattle, donkeys, seasonal crop farming, grass, and wood / timber harvesting. The following is the summary of some of the common general threats to the natural environment and habitats of the general project area inclusive of the AOI and the area covered by the proposed 2D seismic survey operations:

- (i) Accelerated allocation of communal leaseholds resulting in forestry clearing.
- (ii) Subsistence communal crop framing centred on forestry clearing, slash and burn practices.
- (iii) Timber and wood harvesting, and.
- (iv) Overgrazing due to increased number of animals.

Based on the findings of this Environmental Scoping report, it is hereby recommended that EIA and EMP reports shall be prepared to support the application for ECC for the proposed 2D seismic survey operations over the areas of interest within PEL 73. The EIA and EMP shall cover the whole proposed 2D seismic survey line coverages. The EIA and EMP process shall include the following site-specific specialist studies: Field-based flora and fauna and review of the existing water, archaeological, dust, noise, and socioeconomic assessments. Public and stakeholder consultation process shall be organised as part of the environmental assessment process for the proposed 2D seismic survey operations in PEL 73 with special focus on the regional and local communities of Kavango West and East Regions where the project is situated. Public and stakeholder meetings are planned for the 20th and 22nd January 2021 in Nkurenkuru Community Hall and Rundu AMTA respectively, with morning sessions from 10hrs00 to 13hrs00 (formal meeting) and afternoon sessions from 15hrs00 to 18hrs00 open public walk in as needed. The field-based villages meetings will be undertaken in coordination with the regional councillors and traditional authorities from Saturday 23rd to Monday 25th January 2021.

1. PROJECT BACKGROUND

1.1 Introduction

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

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

1. **Step 1:** An applicant develops a theoretical hydrocarbon model and apply for a Petroleum Exploration License (PEL) and once the license is granted there is no requirement for undertaking environmental assessment and obtaining the Environmental Clearance Certificate (ECC) over the entire license area. The environmental assessment and all other permitting are only required once the PEL holder decides to implement exploration activities such as drilling or seismic survey that are listed in the applicable laws or may require other permits as may be applicable.
2. **Step 2:** Collection of the existing key historical data sets pertaining to petroleum geology, sedimentary basin, aerial gravity, magnetics and if the sedimentary basin is unknown, a site-specific stratigraphic well/s drilling operation is undertaken in order to confirm the existence of sedimentary basin / petroleum system delineated aerial geophysical data and other exiting geological data sets.
3. **Step 3:** Once the sedimentary basin has been confirmed and potential target area defined, ground geophysical surveys methods such as 2D seismic surveys are used in the search for potential geological structures that could hold economic oil or gas called reservoirs. This environmental assessment report covers this step 2.
4. **Step 4:** Exploration well drilling is undertaken on the identified geological structure (potential reservoir) based on the interpreted results of the seismic survey in order to test and confirm if the seismic survey delineated geological structure/s contains any economic oil or gas resources. If the drilled exploration well is dry it will be capped and abandoned safely, and.
5. **Step 5:** If there is oil or gas discovered during the exploration well drilling operations, then an appraisal well drilling operations may be undertaken in order to test the size and economics of the discovered oil or gas field. It is during the EIA for appraisal drilling for commercially discovered oil or gas and for possible production from either a conventional reservoir (with natural pores and permeability) or unconventional reservoir (natural pores but limited permeability) that one can now start to talk about fracking. At present Namibia has no commercial or economic or even indicative oil or gas discovered onshore to frightened the public about nonexistence planned fracking. Fracking is not an exploration drilling technique but an oil or gas production method applied after a commercial proved discovery in a reservoir with poor primary permeability.

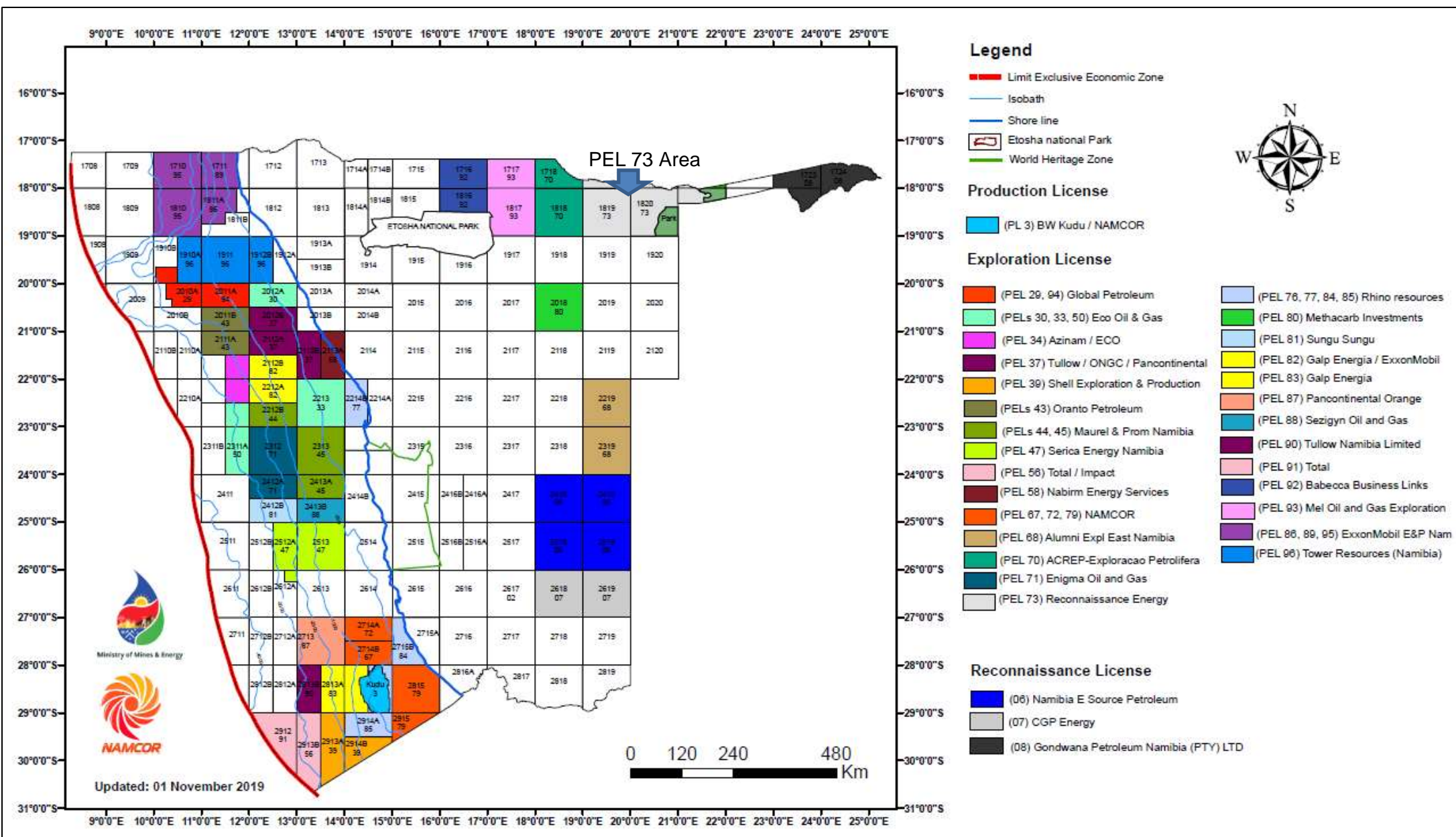


Figure 1.1: Hydrocarbon Map of Namibia (Source: www.namcor.com.na or www.mme.gov.na). Petroleum Licenses are granted as degree (Latitude and Longitude) Square Blocks and several such license have been granted both in the offshore and onshore environments. Plenty more blocks are open for anyone to apply if one has about N\$2million yearly payment to lease such an area from the State inclusive of all other required mandatory State contributions.

1.2 ReconAfrica Work Commitment and Obligations for PEL 73

1.2.1 Initial Exploration Period (4 years)

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

1.2.2 First Renewal Exploration Period

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

1.2.3 Second Renewal Exploration Period

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

1.2.4 Production License

If ReconAfrica's exploration work leads to an economically viable project (discovery of economic oil and gas reserves), the Company may apply for a 25 year production license, which should be granted within 6 months of the date of application. The terms of the production license are a 5% royalty, and a 35% corporate tax rate. In addition, a three-tiered Additional Profits Tax (APT) is payable on the after-tax net cash if certain after tax, inflation adjusted rates of returns are met. The first hurdle rate is 15%, with the second and third tiers at 20% and 25%. Exploration, development and operating expenditures, as well as royalty and corporate income tax, are all fully deductible in the year they are paid in the computation of the APT net cash flow for the year. The first-tier rate of APT is established in the legislation (through a formula) at 25%. The incremental second and third tier APT rates are determined in the Petroleum Agreement, and in the case of Reconnaissance, are 28% and 29% respectively.

Note: The scope of this environmental assessment only covers the exploration phase and specifically focusing only on the proposed 2D seismic survey operations and has nothing do with the production phase and possible method/s of production because no oil or gas has been discovered and the unknown cannot be measured.

1.3 Current Exploration Status, Motivation and Purpose

1.3.1 Current Exploration Status

Subsequent to the grant in 2015 ReconAfrica purchased additional high resolution aeromagnetic data covering the Licensed Property and conducted a detailed analysis of the resulting data and other available data related to the block, including reprocessing and reinterpretation of all existing geological and geophysical data. This led to the identification of the Kavango Basin as the key Area of Interest within PEL 73. The company intends to conduct 450 km long 2D seismic survey operations as part of the its exploration commitments. The proposed survey operations will be conducted along existing roads and tracks, using the Explorer 860 as the surface energy source and wireless receivers or geophones. The overall aim and objective of conducting the proposed 2D seismic survey operations, is to search for geological structures called reservoirs that may contain economic hydrocarbon. Depending on the outcomes of the proposed 2D seismic survey operations, exploratory drilling

operations over the delineated hydrocarbon structural reservoirs may be undertaken followed by appraisal well drilling operations if there is a commercial oil or gas discovery.

1.3.2 2D Seismic Survey Influences on the Local Communities

Onshore seismic survey operations have been undertaken in Namibia before and the latest being the 2018 2D seismic survey conducted by Acrep in PEL 72 covering Kavango West Region. During any oil and gas exploration programme no community relocation whatsoever does take place and no one will be relocated during the proposed 2D seismic survey operations to be conducted along existing roads and tracks. Community relocations are rarely undertaken and only during the oil or gas field development stages under the Production License following a commercial discovery. This may only happen if there are no coexistence opportunities / alternatives to be explored. Such instances may include; a community settlement located too close to a critical oil and gas supporting infrastructure that cannot be situated anywhere within the discovered oil or gas field. Such infrastructure may include a production well/s, pipeline, power station, refinery or any other supporting infrastructure to the oil or gas field development and operational safety requirements. Such issues will indeed be addressed in separate environmental assessment that may be implemented for the production phase of any discovered oil or gas resources.

1.3.3 Current Project Motivation

The proposed 2D ground seismic survey operations, has some limited and short-term socioeconomic benefits that includes: 3-4 months contractual employment opportunities for the local communities during the survey operations, the payment of the annual license rental fees to the Central Government and USD50, 000.00 annual contributions to the Petroleum Training and Education Fund (PETROFUND) for the duration of the exploration license. It is important to note that in the absence of any commercial discovery for oil and gas in Namibia, annual license fees and contributions to the PetroFund and averaging N\$2 million per Degree Square Block per operator per year are a vital revenue streams for the State and for the benefit of all Namibians. The Petrofund provides local regional and international bursaries and scholarships to seventy (70) Namibians annually.

The seismic survey data to be generated will enrich the national geoscience database held by Namcor and will contribute to the understanding of the regional and local subsurface geology of both Kavango West and East Region. The seismic survey data to be generated will be highly useful in the search for minerals resources, water exploration, geothermal exploration and general geoscience research and development.

In an event of a discovery of economic petroleum resources, the likely new petroleum production operations will have long-term and greater local, regional (Kavango West and East) and national (Namibia) socioeconomic benefits in terms of new jobs and skills development opportunities, broader economic diversification, capital investments, new infrastructural development, license rental fees, royalties payable to Government, long-term direct and indirect contracts and employment opportunities, export earnings, foreign direct investments and various taxes payable to the Government.

The newly discovered Kavango Basin in PEL No. 73 is situated in a highly prospective area of northern Namibia. The Kavango Basin is part of the greater Kalahari Basin which extends into southern Angola, western parts of Zambia and western part of Botswana. Based on the historical exploration activities undertaken around the Etosha Basin situated to the west of PEL 73, and the results of the recently completed aerial gravity and magnetic data interpretations undertaken by ReconAfrica, the Kavango Basin has great exploratory potential for petroleum (oil and gas) occurrence. The regional geology, historical and current exploration activities undertaken, all presents a good probability for discovering economic petroleum (oil or gas) resources in PEL. No. 73.

According to ReconAfrica, (2020), a new extended high-density Aero-Mag survey and other new ancillary data coupled with Halliburton's LithoTect structural interpretation tool have generated a thorough understanding of how deep the Permian rift basin has developed within the Kavango Basin. Specifically, a faulting system has been identified throughout the basin which is responsible for potential conventional fault and stratigraphic hydrocarbon bearing structures.

Yes, there are issues of Climate Change that need to be resolved over long-term (20 – 30 years). Subject to a commercial discovery of oil or gas and the size of the field discovered, an oil and gas field can have an average lifespan of 15 years and revenue from oil or gas derived from such a field over its lifespan can greatly assist Namibia to transform to a greener economy in the next 20-30 years. The discovery of oil or gas or both will solve Namibia's current electricity base load challenges with extra revenue invested in greener energy infrastructures and industries, and build a well-funded Wealth Sovereign fund for future generations.

The current green environmental financing models that are dependent on donations, loans, and grants from developed countries coupled with massive socioeconomic challenges and rural generational poverty, will see Namibia struggle to achieve its net zero 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 also adopted long-term strategies of transforming to greener economies by 2050.

Namibia is a developing country struggling economically with high levels of debt, high unemployment, high poverty levels, challenging social economic issues, riddled with unequal distribution of wealth and majority of the indigenous Namibians swimming in generational poverty. The adoption of coexistence developmental approaches in the diversification of the national resources base will greatly help the country to achieve both the short- and long-term developmental goals for the benefit of all Namibians.

1.3.4 Purpose of this Scoping Report

This environmental assessment is focused only on assessing the environmental impacts associated with the proposed 2D seismic survey exploration method over an area of interest within the Kavango Basin, a very limited portion of PEL 73.

This environmental assessment study has nothing do with the conventional or unconventional production methods for oil and gas that does not exists because one cannot measure the unknown. If there is a commercial discovery, then yes, the environmental assessment studies that will follow for the appraisal and production phases will examine the environment friendliness of the type of production methods that may be used to produce the commercially discovered oil or gas and the opportunities for coexistence with current and future land uses.

The following is summary of the key guiding principles and objectives of the Environmental Assessment (EA) process and, this Scoping Report:

- ❖ Inform the public, stakeholders and Interested and Affected Parties (I&APs) about the proposed 2D seismic survey.
- ❖ Identify the main key affected communities and their concerns, and values.
- ❖ Define the reasonable and practical alternatives to the proposed 2D seismic survey operations.
- ❖ Identify the important issues with potential significant impacts on the receiving environment and guide the preparation of the Environmental Impact Assent (EIA) and Environmental Management Plan (EMP) reports to support the process of applying for Environmental Impact Assessment (ECC), and.
- ❖ Define the boundaries for the EIA and EMP in terms of time, space, subject matter, and applicable specialist studies.

The overall approach to the preparation of this Scoping report covered the review of the receiving environment (physical, biological, socioeconomic and ecosystem services, function, use values and non-use) with respect to the proposed 2D seismic survey operations to identify the key issues to be addressed in the EIA and EMP reports.

1.4 Project Location

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

Although a PEL may be a very large area defined by the Degree Square Blocks which is good for the State in terms of the subsurface annual rental income, the key area of interest (Sedimentary Basin) is usually highly localised and controlled by the regional and local geology and petroleum system not the boundary of the license area and its proximity to a sensitive area (Figs 1.3 and 1.4). It is the proximity of the AIO or a discovered oil or gas field boundary to a sensitive area that is important. Within a PEL area, a local AOI is often delineated based on the interpretation of technical data and in an event of a commercial discovery, even more localised is the oil or gas field area within the AOI. Within the PEL, AOI or oil or gas field boundaries, only localised areas where the actual activities are taking place that defines the actual surface footprint of the operation with subsurface target/s situated very deep about 3-4km.

At present here there is no oil or gas discovery within AOI and there no oil or gas field boundary that has been delineated. An oil or gas field within an AOI can only be delineated following a commercial discovery and completion of an appraisal well drilling and testing operation before actual field development can even be contemplated. An oil and gas field is usually a localised area within the entire AOI which is used for producing oil or gas.

1.4.2 PEL 73 License Area

The PEL 73 which is granted as a Degree Square Blocks as provide for in the Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991) covers an area of approximately 25,341.33 sq km (6.3 million acres) (Fig. 1.4). PEL No. 73 covering Blocks 1719, 1720, 1721, 1819, 1820 and 1821 falls within the Kavango Basin forming part of the greater Etosha Basin of northern Namibia falling within the greater Kalahari Sediments of Southern Africa.

1.4.3 The Area of Interest (AOI) Within PEL 73

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

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

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

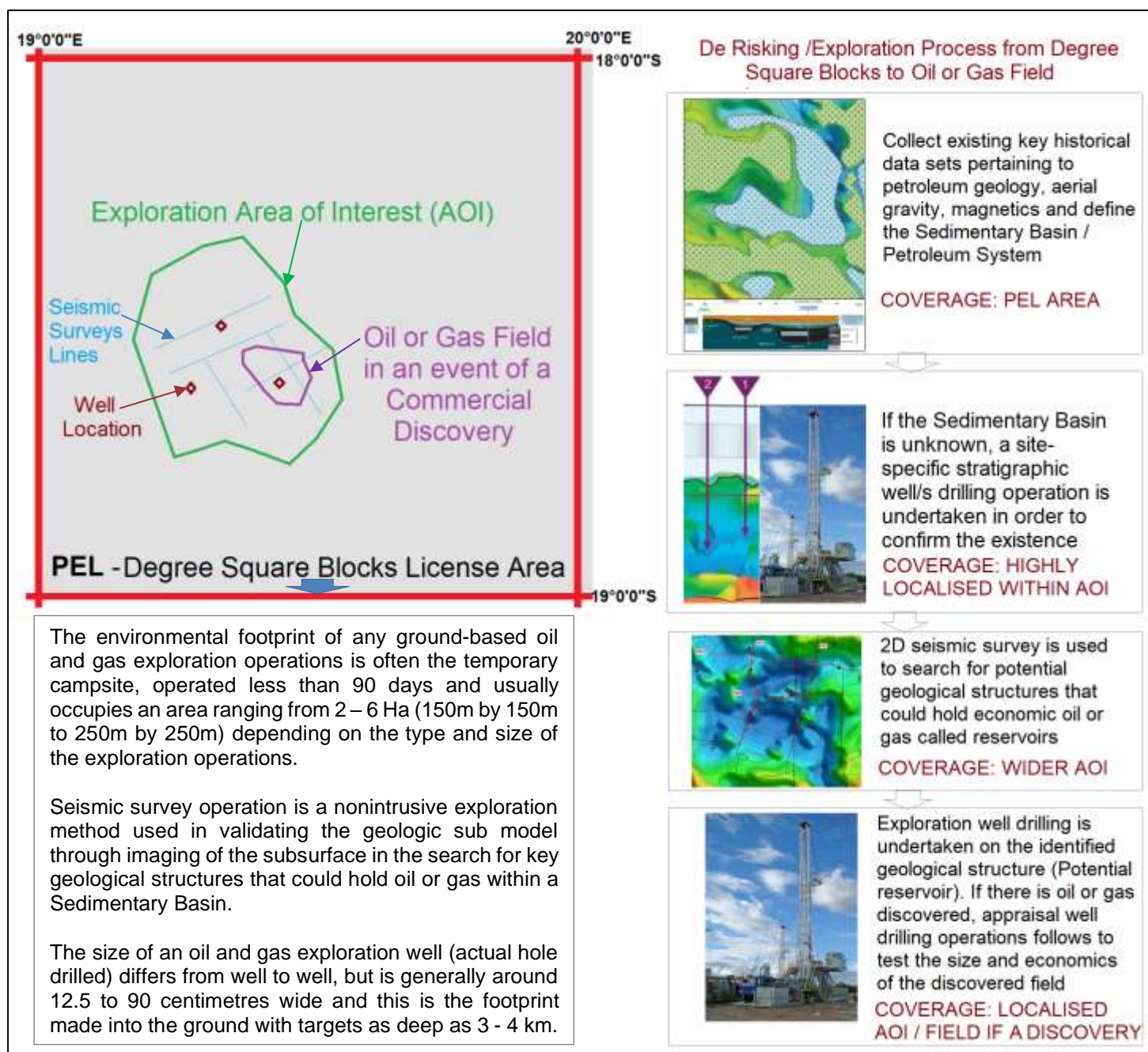


Figure 1.3: Size and exploration footprint illustration over a License Area (PEL) (subsurface rental area), Sedimentary Basin exploration Area of Interest (AOI), Sedimentary Basin seismic survey area, Sedimentary Basin drilling location and oil or gas field in an event of a commercial discovery with respect to the de-risking / exploration process.

1.4.4 Location of the Proposed 2D Seismic Survey Lines

The PEL 73 covering Blocks 1718 and 1818 is situated in the Kavango West Region in northern Namibia (Figs. 1.4 and 1.5). The greater parts of the license area are general sparsely populated with much of the population concentrated along the Okavango River marking the border between Namibia and Angola. PEL 73 and the proposed 2D seismic survey area covers parts of both the Kavango West and East Regions in northern Namibia (Figs. 1.4).

Within the key areas of interest, the following tribal (traditional) authorities falls within the Kavango East Region: Shambyu, Gciruku and Mbukushu tribal authorities (Fig. 1.6).

Within the key areas of interest, the following tribal (traditional) authorities falls within the Kavango East Region: Kwangali and Mbunza tribal authorities (Fig. 1.6). The following is the locations of the each of the proposed 2D seismic survey lines with respect to the regional and traditional authorities administrative / governance boundaries (Fig. 1.6):

- (i) Line NS-1: Covers Kavango East and West Regions; Ncuncuni, Ncamagoro and Mashare Constituencies; and Mbunza and Shambyu Traditional Authorities (Figs. 1.5-1.7 and Plates 1.1 -1.3).
- (ii) Line NS-2: Covers Kavango East Region; Mashare Constituency; and Shambyu Traditional Authority (Figs. 1.5-1.7 and Plates 1.4 -1.7).
- (iii) Line NS-3: Covers Kavango East Region; Ndiyona Constituency; and Gciruku Traditional Authority (Fig. 1.5-1.7 and Plate 1.8).
- (iv) Line NS-4: Covers Kavango East Region; Mashare and Ndonga Linena Constituencies; and Shambyu Traditional Authority (Figs. 1.5-1.7 and Plate 1.9).
- (v) Line NS-5: Covers Kavango East Region; Rundu Rural Constituency; and Shambyu Traditional Authority Figs. 1.5-1.7 and Plates 1.10 and 1.11).
- (vi) Line EW-1: Covers Kavango East and West Regions; Ncuncuni, Rundu Rural and Mashare Constituencies; and Mbunza and Shambyu Traditional Authorities (Figs. 1.5-1.7 and Plates 1.12 -1.14).
- (vii) Line EW-2: Covers Kavango East Region; Mashare Ndonga Linena and Ndiyona Constituencies; and Shambyu and Gciruku Traditional Authorities (Figs. 1.5-1.7 and Plate 1.15).
- (viii) Line EW-3: Covers Kavango East and West Regions; Ncuncuni, Rundu Rural and Mashare Constituencies; and Mbunza and Shambyu Traditional Authorities (Fig. 1.5-1.7 and Plates 1.16 -1.18).
- (ix) Line EW-4: Covers Kavango West Region; Ncuncuni Constituency and Mbunza Traditional Authority (Figs. 1.5-1.7 and Plates 1.19-1.21), and.
- (x) Line EW-5: Covers Kavango West and East Regions; Ncamagoro, Ncuncuni and Mashare Constituencies and Mbunza and Shambyu Traditional Authorities (Figs. 1.5-1.7 and Plates 1.22-1.24).

1.4.5 Accessibility

The main access to the survey area can be undertaken by 4 by 4 vehicles either through the already exiting gravel roads, sandy roads and tracks connecting small settlement (Figs. 1.5-1.7 and Plates 1.1 -1.24). The survey area and all the profiles / survey lines do follow existing road or tracks ((Figs. 1.5-1.7 and Plates 1.1 -1.24).

Very few areas along the survey lines will require the widening of the existing sandy access resulting in cutting of the local bushes to be fully assessed in the EIA report with key mitigation measures to be provided in the EMP.

No big trees shall be cut unnecessary because of widening access because no new cut line will be created. The survey will be conducted from the month of April which is the dry season with no effect on the local subsistence farmland.

The location of the proposed profiles / survey lines follows existing tracks and are based on the results of the field-based scouting and verification undertaken by Risk-Based Solutions team during the months of November and December 2020 (Plates 1.61-1.24).

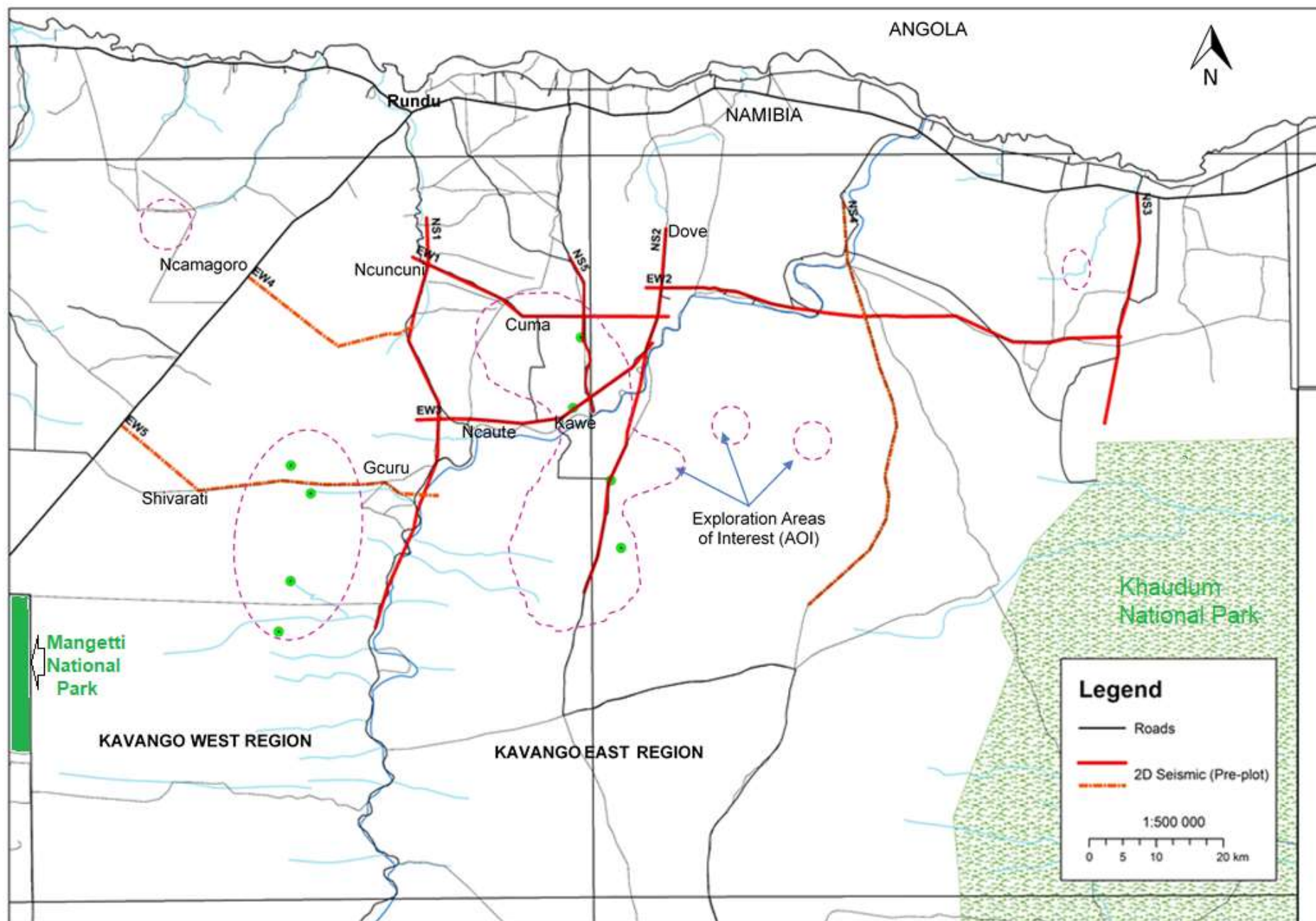


Figure 1.5: Detailed location of the proposed 2D seismic survey lines and key exploration Area of Interest within PEL 73. All the survey line are located on existing roads and tracks (Source: ReconAfrica, 2021).

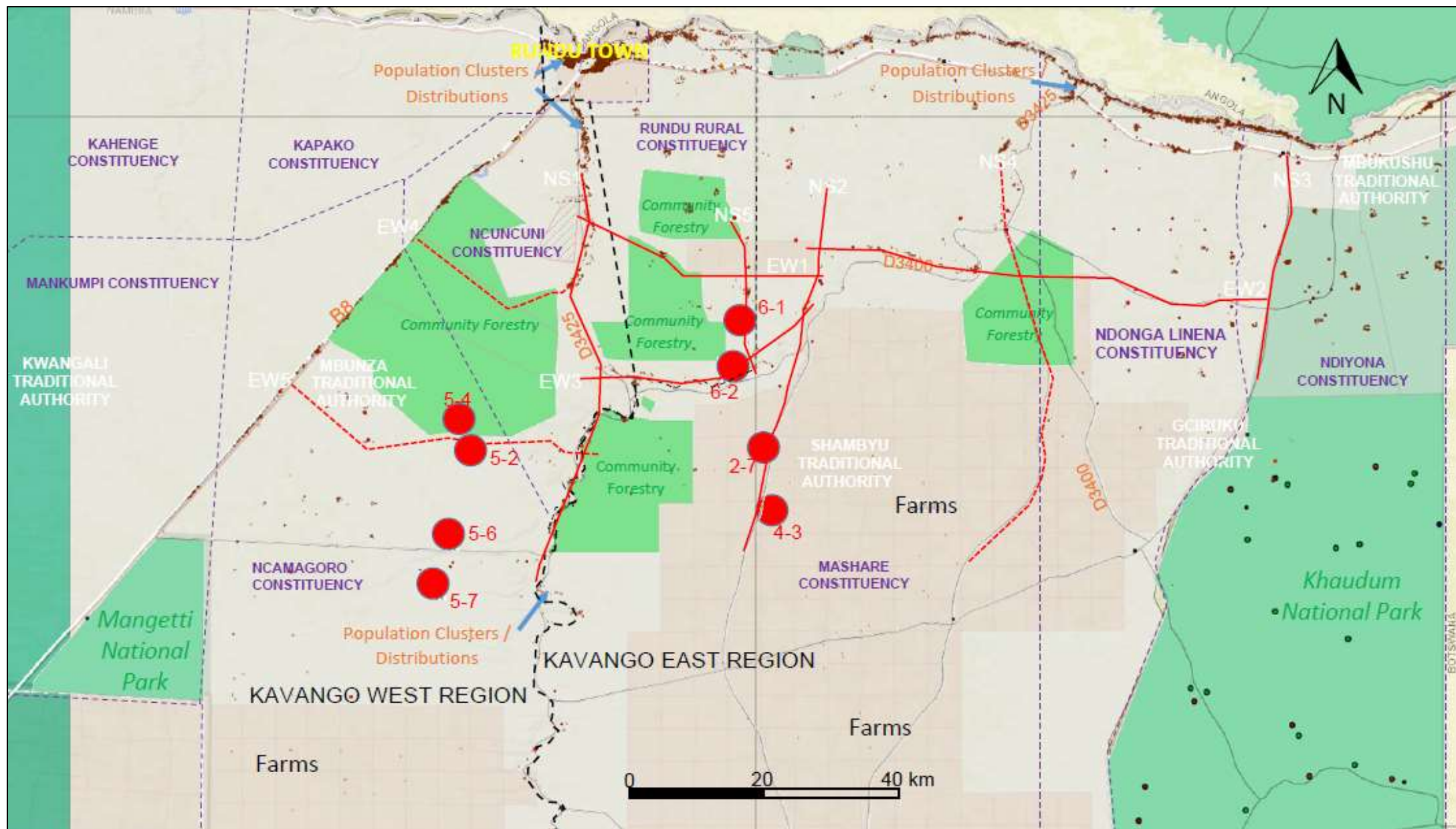


Figure 1.6: Detailed location of the proposed 2D seismic survey lines with respect to various other land uses and community forestry. Roads and tracks exist through the community forestry and no new cut line will be initiated.

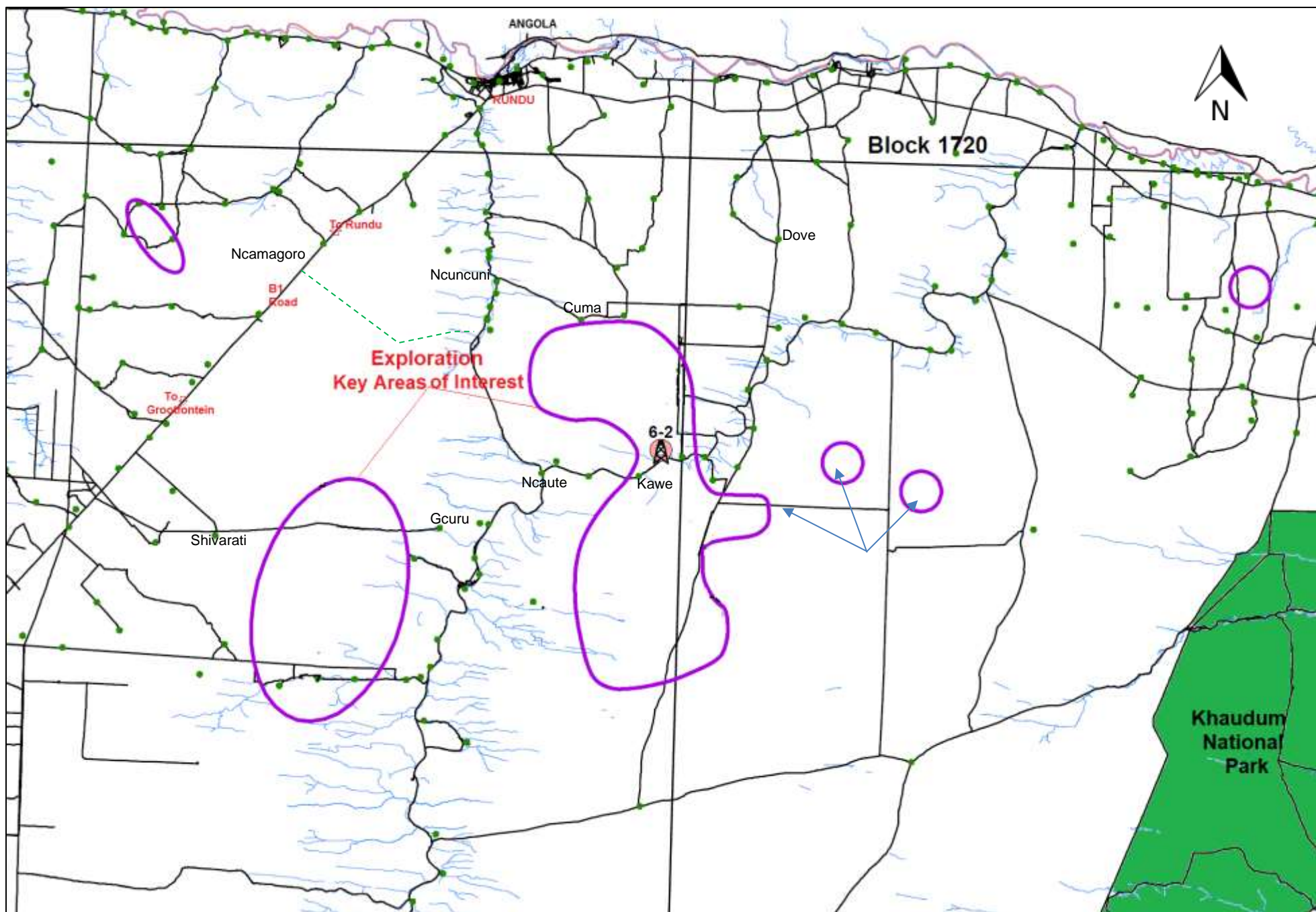


Figure 1.7: Field-based verified existing access road roads and tracks to be used for the proposed survey lines.



Plate 1.1: North section of the proposed 2D seismic survey Line NS-1 detailed location shown by a drone aerial view to the south along the D3425 road from Rundu to Ncaute.



Plate 1.2: Mid-section of the proposed 2D seismic survey Line NS-1 detailed location shown by a drone aerial view to the north along the D3425 road from Rundu to Ncaute.



Plate 1.3: South section of the proposed 2D seismic survey Line NS-1 detailed location shown by a drone aerial view to the north (towards Ncaute) along the D3425 road south of Ncaute and west of the Omatako Ephemeral River.



Plate 1.4: North section of the proposed 2D seismic survey Line NS-2 detailed location shown by a drone aerial view to the north (towards Dove) along the existing tracks linking Dove to the D3400.



Plate 1.5: North section of the proposed 2D seismic survey Line NS-2 detailed location shown by a drone aerial view to the south (towards D3400 Road junction) along the existing tracks linking Dove to the D3400.



Plate 1.6: Mid-section of the proposed 2D seismic survey Line NS-2 detailed location shown by a drone aerial view to the north along the D3400 Road towards junction with the existing tracks linking Dove to the D3400.

Line NS-2 →

Omatako Ephemeral River

Line NS-2 →

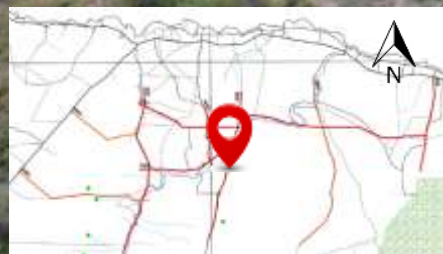
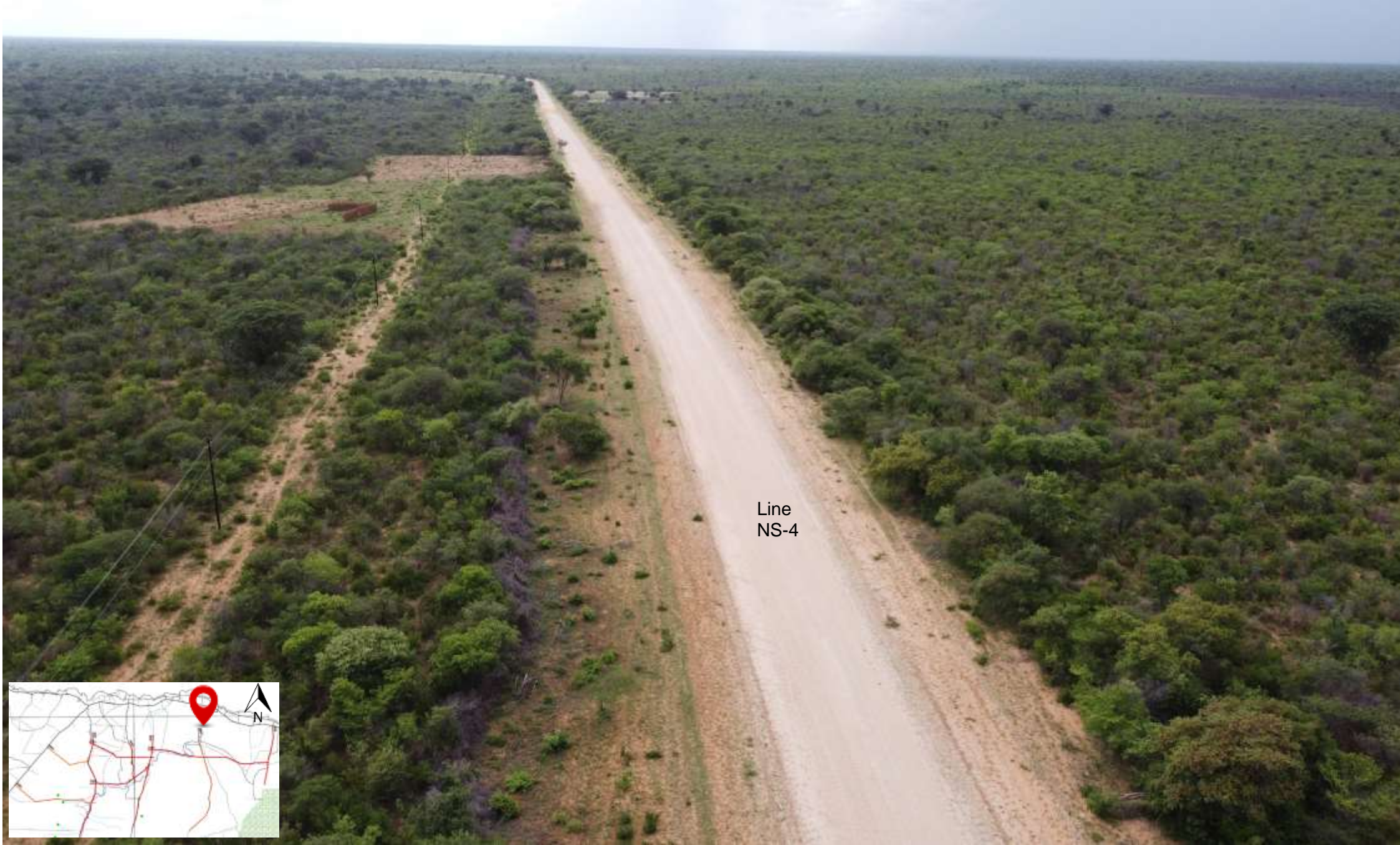


Plate 1.7: Mid-section of the proposed 2D seismic survey Line NS-2 detailed location shown by a drone aerial view to the south along the existing track linked to the D3400.



Plate 1.8: North-section of the proposed 2D seismic survey Line NS-3 detailed location shown by a drone aerial view to the south along the existing 4 by 4 sandy track linked to Khaudum National Park and linked to the B8 at Katere junction.



Line
NS-4

Plate 1.9:

North-section of the proposed 2D seismic survey Line NS-4 detailed location shown by a drone aerial view to the south along the D3400 linked to the B8.



Plate 1.10: North-section of the proposed 2D seismic survey Line NS-5 detailed location shown by a drone aerial view to the south along the new Rundu to Mbambi Roads D3448 and D3468 from the junction to Cuma along the new D3401 Road.



Plate 1.11: North-section of the proposed 2D seismic survey Line NS-5 detailed location shown by a drone ground view to the east showing the new Rundu to Mbambi Roads D3448 and D3468 from the junction to Cuma along the new D3401 Road.



Plate 1.12: South-section of the proposed 2D seismic survey Line EW-1 detailed location shown by a drone aerial view to the east along the new D3401 Road from Ncuncuni to Cuma passing through the community forestry.



Plate 1.13: Mid -section of the proposed 2D seismic survey Line EW-1 detailed location shown by a drone aerial view at Cuma to the west along the new D3401 Road from Ncuncuni to Cuma passing through the community forestry.



Plate 1.14: Eastern -section of the proposed 2D seismic survey Line EW-1 detailed location shown by a drone aerial view to the east at cross cutting with NS-5 at the Rundu to Mbambi Roads D3448 and D3468 from the junction to Cuma along the new D3401 Road.



Line
EW-2

Plate 1.15: West -section of the proposed 2D seismic survey Line EW-2 detailed location shown by a drone aerial view to the east along the D3400 and passing through the community forestry.



Plate 1.16: Mid -section of the proposed 2D seismic survey Line EW-3 detailed location shown by a drone aerial view to the east along the D3400 Road from Kawe.



Plate 1.17: Mid -section of the proposed 2D seismic survey Line EW-3 detailed location shown by a drone aerial view to the west along the D3400 Road at Kawe wood processing facility.



Plate 1.18: Eastern -section of the proposed 2D seismic survey Line EW-3 detailed location shown by a drone aerial view to the west (towards Kawe and current drilling location 1) along the new D3400 Road.



Plate 1.19: Eastern -section of the proposed 2D seismic survey Line EW-4 detailed location shown by a drone aerial view to the east from the B8 Road. The EW-4 survey line run through an existing Community Forestry track to Hamoye along the D3400 Road from Rundu to Ncaute.



Plate 1.20: Mid -section of the proposed 2D seismic survey Line EW-4 detailed location shown by a drone aerial view to the northeast within the middle of the community forestry. The EW-4 survey line run through an existing Community Forestry track to Hamoye along the D3400 Road from Rundu to Ncaute.



Plate 1.21: Eastern-section of the proposed 2D seismic survey Line EW-4 detailed location shown by a drone aerial view to the west through the community forestry near Hamoye along the D3400 Road from Rundu to Ncaute.



Plate 1.22: Western-section of the proposed 2D seismic survey Line EW-5 detailed location shown by a drone aerial view to the east along the existing track from the B8 junction to Gcaru through Shivarati.



Plate 1.23: Western-section of the proposed 2D seismic survey Line EW-5 detailed location shown by a drone aerial view to the east along the existing track from the B8 junction to Gcaru through Shivarati.



Plate 1.24: Eastern-section of the proposed 2D seismic survey Line EW-5 detailed location shown by a drone aerial view to the west along the existing track from Gcaru to Shivarati.

1.5 Onshore Petroleum Exploration History

1.5.1 Overview of Onshore Petroleum Exploration History

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

1.5.2 History of Petroleum Exploration in Northern Onshore Namibia

The following is the summary history on oil and gas exploration activities covering aerial and ground geophysical survey (aeromagnetics, gravity and seismic surveys) and well drilling operations in northern onshore Namibia inclusive of the newly discovered Kavango Basin by ReconAfrica (Figs. 1.8 – 1.10, Miller, 1992; Hoak, *et. al.*, 2014 and ReconAfrica, 2020):

(i) Aeromagnetics, Gravity and Seismic Survey conducted in northern Namibia since 1962 (Figs. 1.8 – 1.10):

- ❖ 1962: Regional aeromagnetics survey by Texas Eastern.
- ❖ 1963: Ground-based gravity survey by Ray Geophysical.
- ❖ 1968-1970: 2D Vibroseis seismic program by Etosha Petroleum.
- ❖ 1990: 2D seismic by Overseas Petroleum Investment Corporation (OPIC).
- ❖ 1990: Aerogravity data by Overseas Petroleum Investment Corporation (OPIC).
- ❖ Since 1992: Namibian Government with support from the European Union and Germany Government has acquired high resolution magnetic and radiometric data over the whole country as well as gravity, electromagnetic and hyperspectral data sets on selected areas.
- ❖ 2003: Aeromagnetics and gravity survey conducted by First African Oil (circle Oil).
- ❖ 2012: Aeromagnetics and gravity survey conducted by Preview Energy (Pty) Ltd (Permitting and technical support provided by Risk-Based Solutions).
- ❖ 2013: Aeromagnetics and aerogravity survey by Hydrocarb Energy, and.
- ❖ 2018: 2D seismic survey by Acrep Exploracao Petrolifera SA (Permitting and additional support provided by Risk-Based Solutions).

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

- ❖ 1967: Regional surface geochemistry study by Etosha Petroleum.
- ❖ 1967: Photo Geology survey by Etosha Petroleum.
- ❖ 1992: Surface soil gas study by Occidental International.

- ❖ 2010: Apatite Fission Track Analysis (AFTA) from the Etosha Strat Test #1 and 5-1A wells study conducted by Preview Energy (Pty) Ltd (Permitting and technical support provided by Risk-Based Solutions).
- ❖ 2012: Field-based outcrops sampling for source and reservoir rocks by Preview Energy (Permitting and technical support provided by Risk-Based Solutions).
- ❖ 2012 and 2013: Field-based outcrops sampling for source and reservoir rocks by Hydrocarb Energy.
- ❖ 2012: Limited soil gas survey by Frontier Resources west of PEL 73 in PEL 72.
- ❖ 2015: ReconAfrica purchased additional high resolution aeromagnetic data covering the Licensed Property and conducted a detailed analysis of the resulting data and other available data related to the block, including reprocessing and reinterpretation of all existing geological and geophysical data. This led to the identification on the Licensed Property of the Kavango Basin, and.
- ❖ 2018: Geochemical soil sampling by Acrep Exploracao Petrolifera SA (Permitting and additional support provided by Risk-Based Solutions).

(iii) **Well drilling operations conducted in northern Namibia since 1964 (Fig. 1.8):**

- ❖ 1964: Stratigraphic Test #1 well (Total Depth 1890 m) was drilled by Etosha Petroleum.
- ❖ 1970: Etosha 1-1 (Total Depth 1593 m) and 2-1 (Total Depth 1235 m) wellbores two shallow wells and one deeper test and the Etosha 5-1A (Total Depth 2523 m) deeper test were drilled by Etosha Petroleum, and.
- ❖ 2020: ReconAfrica proposed to drilled two (2) – three (3) stratigraphic wells to confirm the presence of the newly discovered Kavango Basin.

1.5.3 Future Opportunities for Petroleum Exploration in Northern Onshore Namibia

Based on the above summary of historical exploration activities that have been undertaken in northern Namibia since 1962, the exploration activities being conducted by ReconAfrica in PEL 73 adds on what has been undertaken in the past by extending the data coverage to the east of the Etosha Basin into the newly discovered Kavango Basin.

The drilling of the proposed stratigraphic wells and the acquisition of the proposed 2D seismic survey by ReconAfrica are not new when it comes to oil and gas exploration operations in northern Namibia or any other part of the World. Since 2010, Dr Sindila Mwiya through Risk-Based Solution has technically supported various operators exploring for oil and gas in northern Namibia and continue to do so to this day. To date, the PEL 73 has no historical drilling operations or 2D seismic data acquisition, with the closest subsurface well control being the ST-1 well drilled 375 km to the west of the Kavango Basin in PEL 73 (ReconAfrica, 2020).

The last well to have been drilled in northern Namibia was in 1970 and the proposed two (2) to three (3) stratigraphic wells to be drilled by ReconAfrica will be the first and deepest (~3200m) onshore wells to be drilled in an independent Namibia. This will be a great milestone and the data will greatly contribute to the understanding of the deep subsurface geology and associated potential natural resources such as oil or gas, minerals, water, and geothermal energy that may be found onshore northern Namibia.

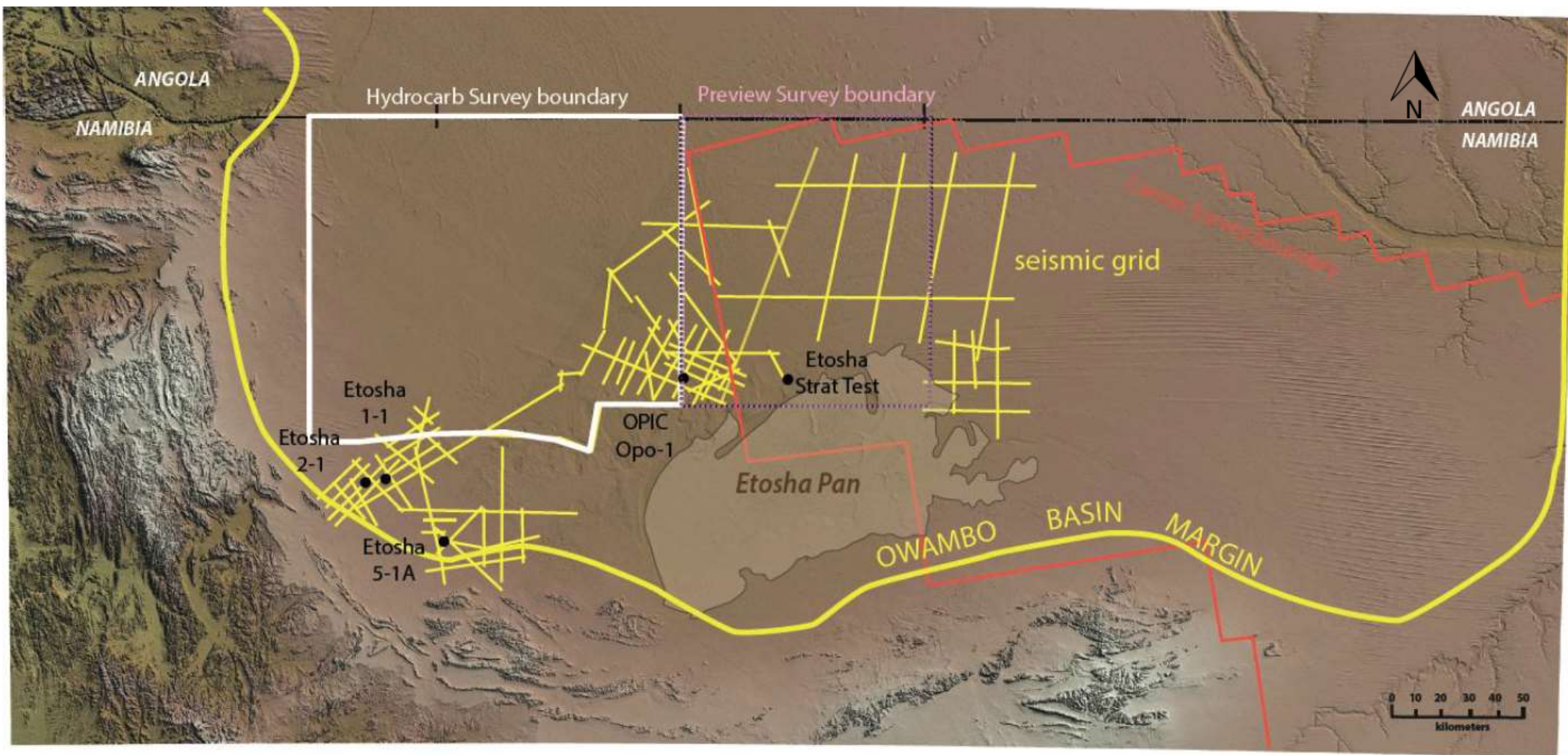


Figure 1.8: Digital elevation model of Owambo (Etosha) Basin showing the historical magnetic/gravity survey boundaries, seismic grid, and well locations (Source: Hoak, *et. al.*, 2014).

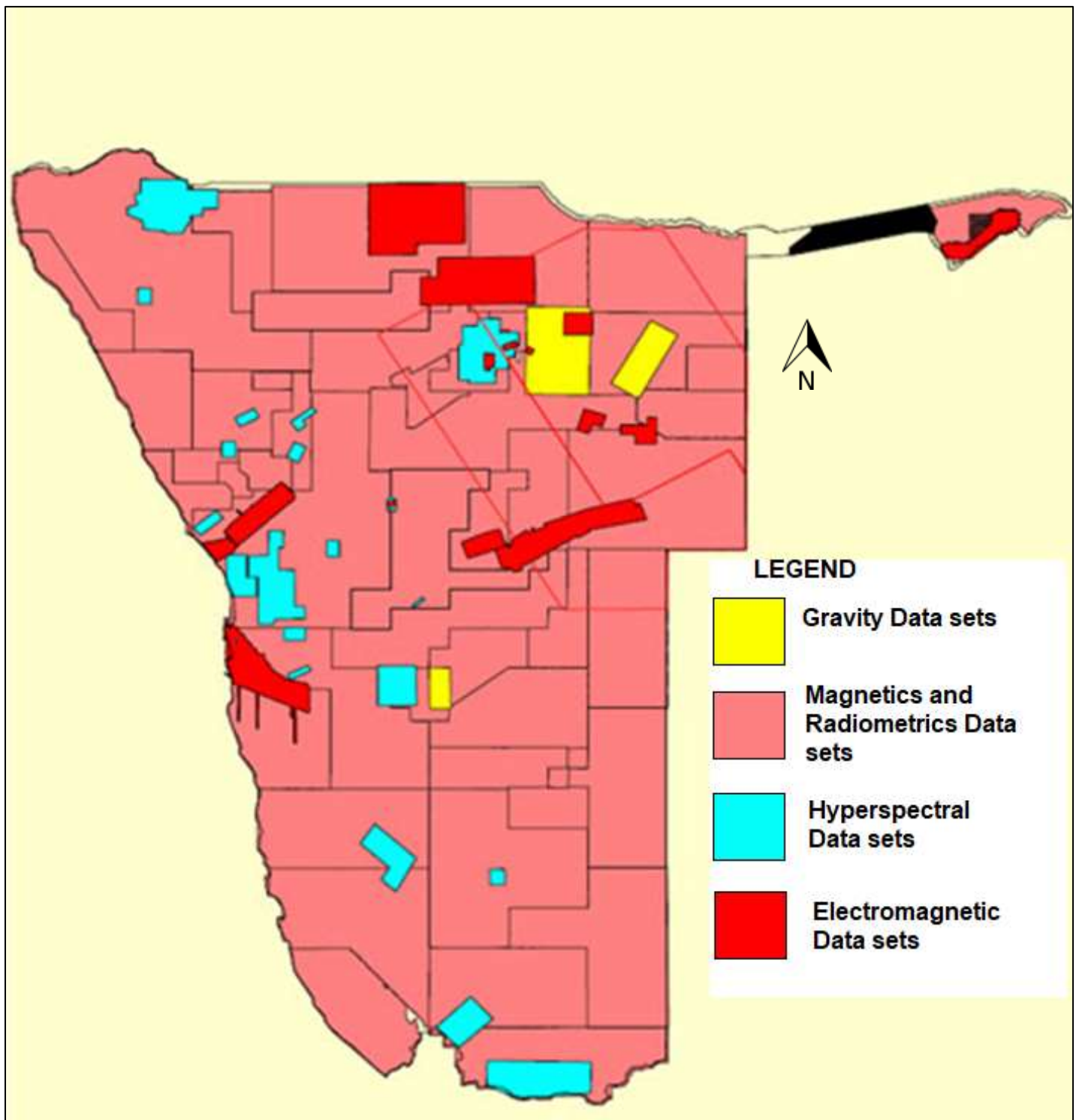


Figure 1.9: Overview of the existing geophysical Government data coverage over Namibia (Source: www.mme.gov.na).



Figure 1.10: Historical seismic survey in the general area showing the location of the recent, 2018, 2D seismic survey that was conducted by CGG using Vibroseis trucks on behalf of the license holder Acrep covering PEL 72 situated west of PEL 73. With the permitting and monitoring support by Risk-Based Solutions team, the ground seismic survey was conducted successfully with the participation of the local communities along the survey lines and witnessed in the field by the Hon. Governor of the Kavango West Region, Councillors, and traditional authorities. Similar field-based organisation arrangements will be adopted for the proposed 2D seismic survey in PEL 73 by ReconAfrica.

1.6 Structure of the Report

The following is the summary structure outline of this scoping report.

- ❖ **Section 1: Project Background** covering Introduction, project motivation, site description and detailed seismic survey line locations and history of oil and gas exploration onshore northern Namibia.
- ❖ **Section 2: Description of the Proposed Project** covering origin of oil and gas, understanding oil and gas exploration process, and detailed description of the proposed 2D seismic survey operations.
- ❖ **Section 3: Regulatory Framework providing** a summary of the applicable legislations and permitting requirements.
- ❖ **Section 4: Receiving Environment** covering physical environment (climate, water, air quality, and geology), Biological environment (flora, fauna and ecosystem services and functions) and socioeconomic environment.
- ❖ **Section 5: EIA and EMP Terms of Reference (ToR)** covering assessment procedure, alternatives considerations, likely positive and negative impacts, impact assessment and overall key summary of impacts associated the proposed 2D seismic survey operations, and.
- ❖ **Section 6: Scoping Conclusions and Recommendations** covering the key issues identified and summarised recommendations.

2. PROPOSED PROJECT SUMMARY

2.1 Origin of Petroleum and Petroleum Exploration

Petroleum (oil and gas) is formed from the remains of ancient marine organisms, such as plants, algae, and bacteria in geological environment called Sedimentary Basins (Fig. 2.1). A Sedimentary Basin is a region of the Earth where long-term depressional setting has allowed for the accumulation of thick layers of sediments with remains of ancient marine organisms. As the sediments continue building-up and are buried deeper within a Sedimentary Basin, the various bottom layers that were initially deposited, will be subjected to increasing pressure and temperature because for every 1km that one goes deeper into the earth's crust, the temperature on average increases by 25°C. The increase of temperature and pressure as a result of the weight of the overlaying materials, initiates the process of cooking. If the sedimentary rock has enough organic materials for generating oil and gas and if the subsurface conditions are favourable, oil or gas may be generated within the temperature window range of between 100°C - 120°C and equivalent to the depths of more than 4km. The oil or gas that get deposited within the Sedimentary basin, again if the conditions and geological structures favours its accumulation, will remain trapped until discovered or until the natural conditions within the basin changes and forces the oil or gas to leak or vaporise. Such changes in Sedimentary basin conditions may be as a result of increasing temperature within the basins cooks the oil or gas forces it to vaporise or could also be the opening of the trap that allows the oil or gas to escape and leak out.

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

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

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

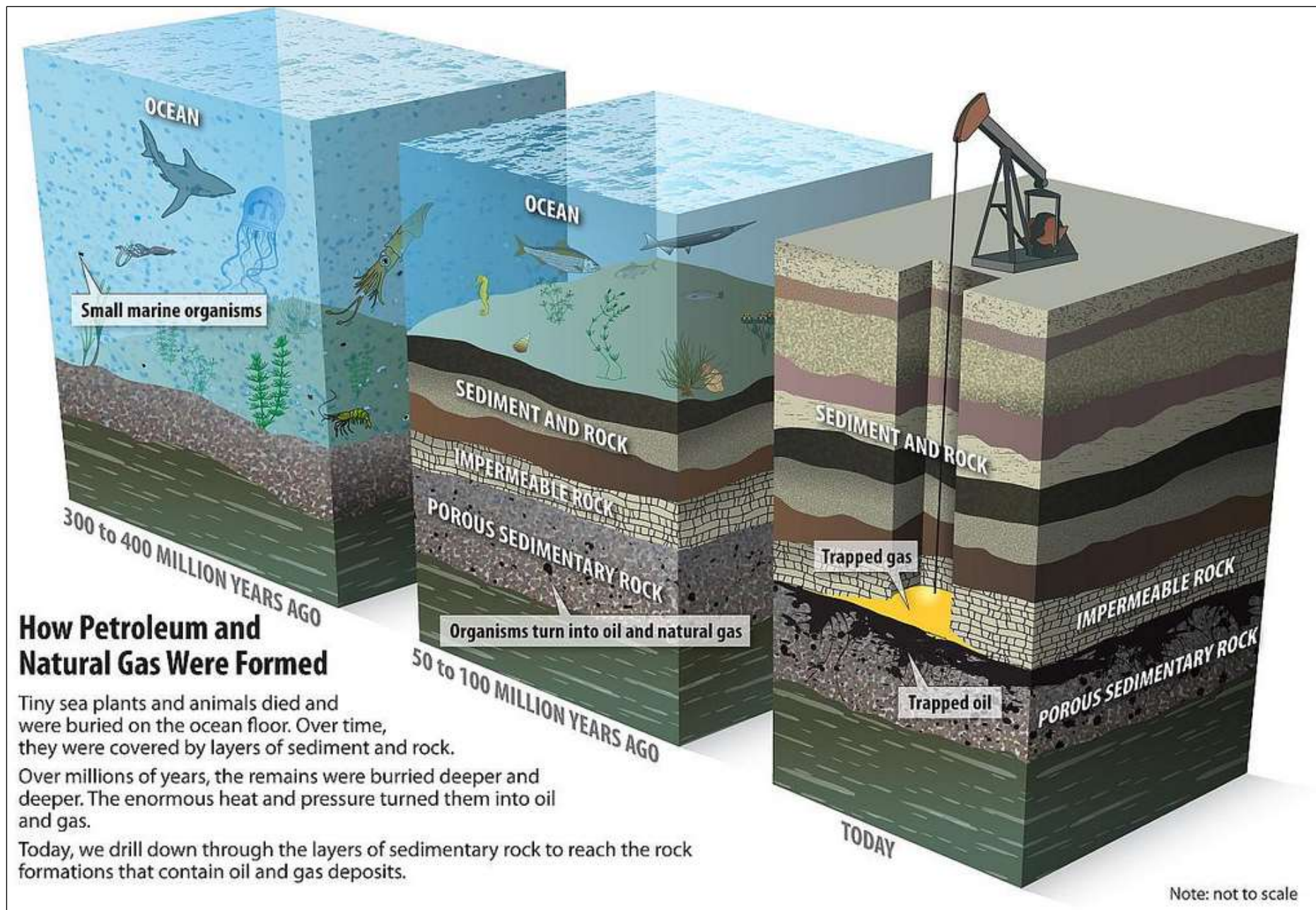


Figure 2.1: Illustration on how oil and gas are formed over millions of years (Source: <https://letslearngeology.wordpress.com/oil-formation-petroleum/>).

2.2 Understanding Petroleum (Oil and Gas) Exploration

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

When developing a theoretical model for oil or gas exploration, all the boundary conditions including the conventional and 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 form of a Sedimentary Basin with potential to host source rocks and reservoir structures with theoretically assumed boundary condition that support the occurrence of economic oil and gas reserves.

The following is a summary of general exploration de-risking activities that are implemented in validating the developed theoretical hydrocarbon model including boundary conditions for identifying site-specific localities with potential for holding economic oil and gas resources or uneconomic resources or nothing because exploration does not guarantee discovery and those undertaking and financing / investing in oil and gas exploration know very well the high stakes and rewards involved in this business:

1. Regional and local desktop study: This is the assessment of all existing data sets such as the geology, environment, hydrogeology, aerial, and ground geophysics (Gravity, Magnetism and Seismic), historical wells drilled in the region and general area. This data is normally purchased from the Government and in Namibia, Namcor sales this data in USD. The overall objective is to build a prospectivity sub model of the licensed area by identifying potential targets or initial leads within the license area. This step covers the whole licensed area and with limited to no fieldwork undertaken.
2. Based on the desktop studies above, usually detailed assessment of any existing geophysical data such as ground or aerial gravity, magnetism or ground seismic is undertaken, although gravity data is one of the key primary data sets. Gravity data is used to identify key areas of interest having thick sediment deposit or build-up (Sedimentary Basins) and such as areas are often coloured blue on gravity map.
3. Magnetic data will often be used to identify geological bodies that may have intruded the potential thick sediment areas (Sedimentary Basins) and if oil and gas was there at the time of the intrusion occurring, then the geological body may have cooked it and forced it to vaporise and disappear. Therefore, high magnetic zones will be no-go zones or not prospective for oil or gas exploration activities.
4. To understand if the identified sedimentary areas without potential magnetic geological bodies have potential geological structural traps called reservoirs that can store oil or gas, ground seismic survey is usually undertaken, followed by drilling of an exploration well/s to test and see if the seismic identified geological traps or reservoirs indeed exist and contain oil or gas and this EIA focuses specifically at this stage of the exploration process (2D seismic survey). However, in some instances the existing geological information can be insufficient to be able to plan and design an exploration well. In order to de-risk the exploration operations especially in a situation where the presence of a sedimentary basin

is unknown, Stratigraphic Test Wells are sometimes drilled, similar to the two (2) to three (3) wells that ReconAfrica is proposing to be drilled. A Stratigraphic Test Well is any well or hole, drilled for the purpose of gathering geological information (logging) in connection with the oil and gas exploration opportunities with no intent to produce oil or gas from such well.

5. If Stratigraphic Test Well drilling operations confirm the presence of a sedimentary basin, 2D or 3D Ground Seismic Surveys are often undertaken before any detailed exploration well/s drilling operation is implemented. Seismic survey works like an Ultrasound imaging also called ultrasound scanning or sonography using sound to generate images of the human body. Seismic surveys use an energy source to generate sound waves used in the imaging of the earth's subsurface in search for potential reservoir structures. These structures will thus be potential targets for exploration well/s drilling operations if the key boundary conditions are favourable.
6. Following the acquisition and processing of the 2D or (3D) seismic data and the delineation of potential geological structures, the drilling of exploration wells follows. An exploration well is drilled to find out if there is any oil or gas at a given locality. Exploration wells are drilled purely for exploratory and information gathering purposes and not for oil or gas production. Several exploration wells have been drilled in both the onshore and offshore environments of Namibia (See Section 1.5).
7. Once an exploration well has discovered oil and gas, the next step in the exploration process is to determine the economics of the find and the de-risking process covers the drilling of multiple appraisal testing wells in order to define the size of oil or gas field discovered. The overall aim is to assess the characteristics of the reservoir and determine if the discovered oil or gas can be produced economically using either conventional and unconventional production methods. However, the discovery of oil or gas does not guarantee a commercial discovery production and a good example is the Kudu Field discovered in 1974 by Chevron Texaco, offshore southern Namibia. The Kudu Gas is situated about 170 kilometres northwest of Oranjemund and in water depth of about 170m. Since its discovery, the field has been owned by several major global oil and gas exploration and production companies and despite being under a Production License, to date no development model has proved favourable to produce the gas from this field. Various production options such as the liquefying of the gas for export to Europe and building of a 170 km long pipeline to a power station that could have been built at Uubvlei, approximately 25 km north of Oranjemund in southern part of Namibia to generate clean electricity, have all failed the economic test, and.
8. The economic evaluation is very a complex process and will consider issues related to how the oil and gas could be produced safely and economically. Subject to the type and characteristics of the oil or gas discovered, considerations for the development of key supporting infrastructure such as a pipeline, a refinery or a power station option will be evaluated with linkages to the technological requirements, national environmental, security, financial and all other applicable national regulations and international standards for oil and gas production.

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

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

During the development process massive capital inflow comes into the country and an array of employment opportunities are often created associated with field development activities and all the supporting infrastructure development process.

2.3 Proposed 2D Ground Seismic Survey as an Exploration Method

2.3.1 Basic Principles of 2D Ground Seismic Survey

Ground seismic survey method are among the proven technologies that are used in the search for earth resources. The results from the 2D ground seismic survey operations will assist in delineating potential target areas suitable for drilling of exploration wells. Land seismic data acquisition uses primarily two types of seismic energy sources, non-impulsive Vibroseis trucks and Explorer 680 or an impulsive energy source such as a low-impact charge that generate acoustic waves which propagate deep into the earth. During the seismic survey, the generated seismic wave which travels into the earth, reflected by subsurface formations, and returns to the surface where it is recorded by receivers called geophones which are like microphones (Fig. 2.2). The resultant product is a vertical sonic cross-section of the subsurface beneath the survey line showing the geological materials (de-risked geological sub model) and structures that the acoustic wave has travelled through (Fig. 2.3). This information is used to predict where oil or gas may be trapped in sufficient quantities for exploration activities.

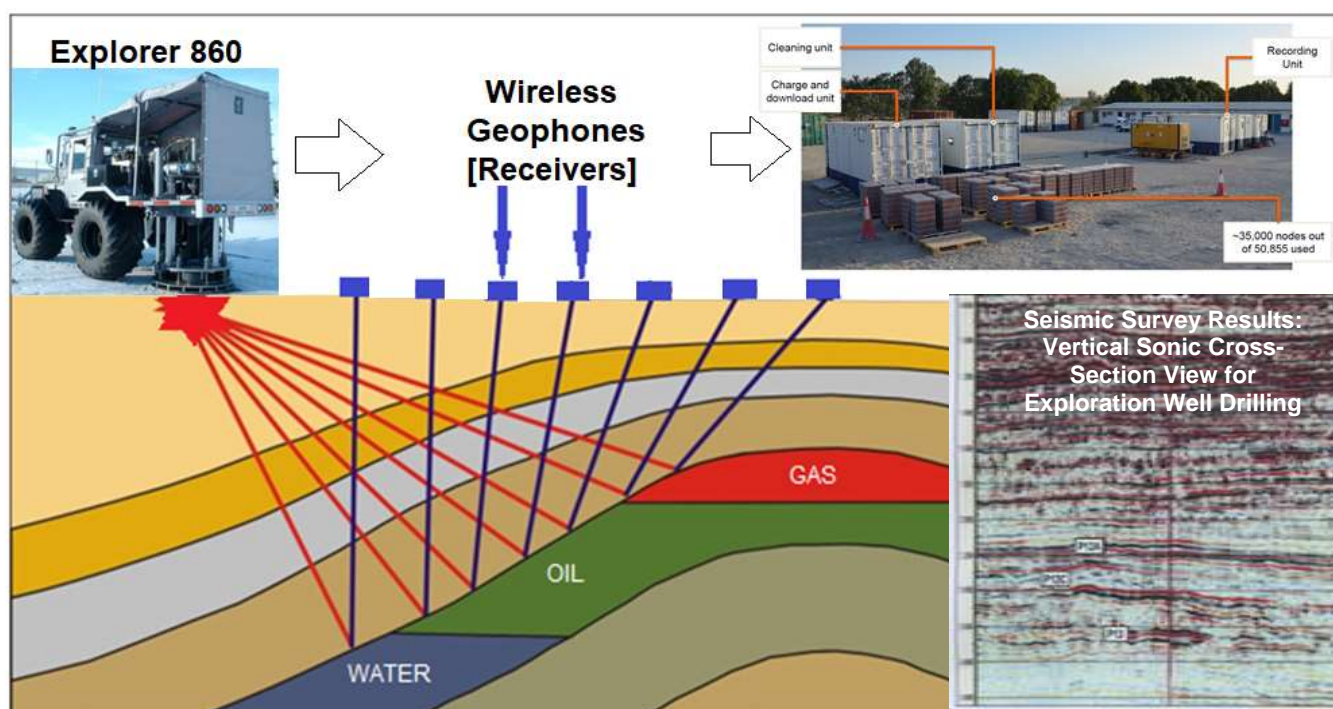


Figure 2.2: Illustration of the 2D ground seismic survey operation to be undertaken in PEL No. 73 along the proposed lines using the Explorer 860 as the energy sources with wireless receivers (Photos Source: <http://www.polarisexplorer.com>).

2.3.2 Vibroseis, Dynamite or Explorer 860 Seismic Operations

2.3.2.1 The Use of Dynamite as an Energy Source

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

The cost of drilling holes for a dynamite-based seismic survey can become a critical factor in the overall design of the survey. This effectively places a limit on the shot line interval, and the shot interval down

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

- ❖ Dynamite is a good energy but once it is gone it is gone since it is not renewable, and.
- ❖ One advantage of dynamite is the high-power source of short duration as such, it creates a compact wavelet with a wide bandwidth. Another advantage a dynamite has over vibroseis trucks are its light weight, low-cost lack of required maintenance and capacity for deployment in rugged terrain unreachable by vehicles (Oriard, 1994). However, the process of drilling shot holes, burying the dynamite, and cleaning up after the operation is labor 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).

2.3.2.2 The Use of Vibroseis as an Energy Source

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

- ❖ Vibroseis has a greater advantage in energy spectrum control as this can be done with much ease than in the use of dynamite. The force applied to the ground can be monitored and adjusted in real time. Hence the effective usage of vibroseis in urban areas. However, vibroseis have great restriction of access in difficult terrains like swamps, mountains and coastal areas (Oriard, 1999).
- ❖ One of the most important characteristics of Vibroseis method is the limitation of the bandwidth of the source. By this way, vibroseis technique allows one to generate only those frequencies which are needed whereas with the case of dynamite, some of the frequencies generated by the blast are ignored during the seismic acquisition, and.
- ❖ Explosive source develops its power in a very short time whereas vibrational sources distribute their power for a sustained period usually several seconds.

2.3.2.3 The Use of the Explorer 860 as an Energy Source

The new source Explorer 860 (Plate 2.1) has the capability of generating a very large surface impact, with a high degree of repeatability, but it also controllable so that the impact effort can be reduced if required. This control has help to minimized ground roll generation and improved the resultant seismic data. The only difference is that instead of hitting the ground with the plate a special aluminium alloy steel is put on the ground and transfers energy to the ground. All the weight is put on the plate and energy is transferred to a recorder. The hammer comes down on the plate leaving next to no imprint on the ground. The impact on the steel, steel on steel and energy is transferred. This method has significantly replaced the dynamite because energy is renewable in this form than in the dynamite system. The following are the key characteristics advantages and disadvantages of using the Explorer 860 as an energy source:

- ❖ The Explorer 860 is the world fastest, strongest and most accurate accelerated weight drop seismic energy source. It is environmentally friendly and has worked in urban and protected areas with virtually zero ground disturbance.
- ❖ Unlike conventional weight drop system, the Explorer 860 is also highly controllable. The system uses hydraulics to raise and lower the weight, and plumbed into the top of the hydraulic cylinder is a nitrogen gas charged accumulator. Pressure in the accumulator can be adjusted, and this pressure controls the force acting on the top of the weight when it is released.
- ❖ Has up to 860,000 lbs of peak force.
- ❖ Faster than the vibroseis.
- ❖ Has very high fold.
- ❖ Has better quality than dynamite.
- ❖ Is perfect for high density population and environmental sensitive areas.
- ❖ Has only single unit required per second source point, and.
- ❖ One disadvantage of Explorer 860 is its capital deployment to site of interest and maintenance.



Plate 2.1: Size comparative of the Vibroseis truck (top) and Explorer 860 Accelerated Weight Drop (AWD) (bottom) (Sources: www.polarisexplorer.com).

2.3.3 Proposed 2D Seismic Survey Design, Layout and Implementation

2.3.3.1 Proposed Survey Design and Layout

The location of the proposed 2D seismic survey lines numbered NS1-NS5 and EW1-EW5 are shown in Figs. 1.5-1.7. Detailed main road accesses through which the proposed survey lines will follow are also shown in Figs. 1.5-1.7 and Plates 1.1 -1.24. The technical design and layout of the proposed 2D seismic survey covers the following key considerations:

- (i) North-south and east west oriented lines have been designed with line layout cutting across the key areas of interest as shown in Figs. 1.5-1.7.
- (ii) All the lines have been designed to follow existing roads or tracks that have been verified to exist (1.5-1.7 and Plates 1.1 -1.24).
- (iii) All the roads and tracks along which the survey will be conducted have been verified to exist as shown in drone views in Plates 1.1 -1.24.

2.3.3.2 Proposed 2D Ground Survey Implementation Stages

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

- (i) Pre-survey scouting in order to assess accessibility and confirm the line survey scouting to be included in the EIA Process.
- (ii) Planning and mobilisation (Tracks / roads preparation (Clearing and widening).
- (iii) Data acquisition (Actual Survey), and.
- (iv) Demobilisation and survey completion.

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

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

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

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

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

Modern survey equipment and techniques will be employed. Survey control will be Established using no less than 4-hour static survey preferably with 2 other baselines running concurrent or Bases

checked with 180 epoch RTK shot. All static survey control will be processed with the Canadian Government Internationally accepted processing utility. Check shots for each roving GPS pack will be made at the start and end of every day and checked in database.

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

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

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

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

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

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

2.3.4 Description of Proposed Data Acquisition Process

The data acquisition process for the proposed 2D seismic survey operations will be undertaken as illustrated in Fig. 2.2. The proposed 2D seismic survey will be undertaken using two (2) to three (3) Explorer 860 Accelerated Weight Drop (AWD) energy source instead of Vibriosis trucks or dynamite. The Explorer 860 AWD provides unrivalled force and production. Polaris Seismic's patented Explorer 860 uses servo-valve and mass Low Vibration Track (LVT) technology to produce the most powerful, repeatable, and productive surface energy source in the World. Table 2.1 shows the parameters design options for the proposed 2D seismic survey in PEL 73.

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

Table 2.1: Proposed 2D seismic survey parameters design options.

	Option 1	Option 2	Option 3
Active Channels	800	800	1000
Source Interval	20m	20	40
Total Source Points	17,500	17,500	8,750
Receiver Interval	20m	20m	20m
Number of Receivers	17,500	17,500	17,500
Geophone	Node	Node	Node
Geometry	7990-10-X-10-7990	7990-10-X-10-7990	9990-10-X-10-9990
Number of Lines	6	6	6
Record Length	6 sec	6 sec	6 sec
Total Kilometers	350 -450	350-450	350-450

EXPLORER 860

BY

Polaris
Explorer Ltd.

Impulse Pack Specifications:

Base Plate Hold down 13,960 Lbs (6332 Kg)
Max Cycle Time = 10 Sec
Peak Force Output = 860,000 lbs (3825 KN)
@ Baseplate
Impulse Frequency = 300 Hz
Max Recorded Shots / Day = 1000

Special Equipment:

- ROPS Certified Rollover protection
- GPS Integrated Electronics
- Low Ground Pressure
- Low Environmental Impact

Chassis Specifications:

Mercedes MB Trac 1100
Front Axle = 5300 lbs (2400 Kg)
Rear Axle = 19980 lbs (9062 Kg)
Total Vehicle = 25280 lbs (11466 Kg)
Vehicle Max Speed = 15 mph (25 kph)

Dimensions:

Overall Width = 112" (2.8 m)
Overall Length = 250" (6.35 m)
Overall Height = 114" (2.9 m)

Engine Specifications:

- 6 Cylinder Diesel, Naturally Aspirated
Power = 110 HP (81 kW) @ 2400 RPM
Torque = 276 Lb·Ft (375 NM) @ 1800 RPM

Transmission / Drive train Specifications:

- 4+2+Hi/LOW Manual Transmission
- 4 Wheel Drive With Differential Lock
- Front Air Ride Suspension

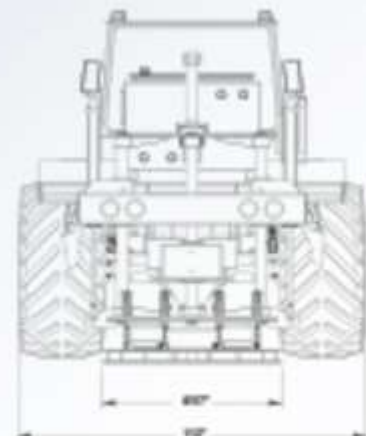
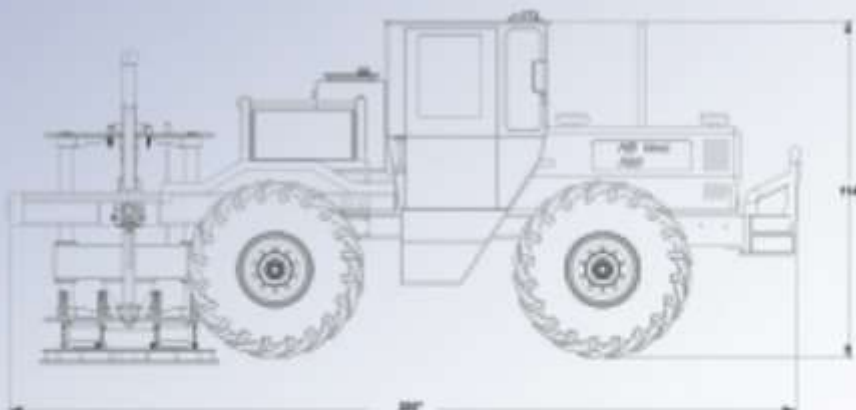


Figure 2.3: Specifications of the Explorer 860 to be used as the energy source for proposed 2D seismic survey operations in PEL 73 (Source: www.polarisexplorer.com).

2.3.5 Recording / Geophones

Energy source points and receiver points will be placed along each of the survey lines targeted to be surveyed. The receiver points whose main purposes will be to record the reflected vibrations from Vibroseis. The spacing of the source and receiver points is determined by the design and objectives of the survey and for the proposed 2D survey. Wireless geophones / receivers / recorders will be used in the proposed survey (Plate 2.2).

The proposed survey will use the STRYDE recording technology which represents the latest, smallest, and most easily deployed system on the market with the following specifications (Plate 2.2):

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

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

- ❖ 2,000 nodes available (or more as may be required for higher density options).
- ❖ Three (3) Layout crews with 3 men per crew.
- ❖ Two (2) Pick-up crews with 2 men per crew.
- ❖ Layout of 1000+ Nodes per day.
- ❖ Pick-up of 1000+ Nodes per day, and.
- ❖ Concurrent harvesting and charging of 900 Nodes per day.



Plate 2.2: The STRYDE wireless recording instrumentation is the latest technology to be used for the proposed 2D seismic survey operations.

2.3.6 Data Processing and Interpretation

A Seismic Quality Control Field Processor and required onsite data processing will be onsite for the entire duration of the proposed 2D seismic survey operations (Plate 2.3). Field Processing will be completed daily with the requested processing flows outlined in the Scope of Work. Processing software includes the current Vista Field Pro software system. All supporting equipment and services will be available including plotters, monitors, etc. STRYDE systems do not process data but output raw gathers / receiver data subject to 125hz “high cut filter”. Very-small-aperture terminal (VSAT) communications will allow transmission of data to processing centres as required by ReconAfrica.

The data recorded from the seismic survey will be raw or in unprocessed form. Before it can be used, it must go through a series of computerised processes. These processes such as filtering, stacking, migrating and other computer analysis, make the data useable and require powerful computers and sophisticated computer programs. As computers have become more powerful and processing techniques more sophisticated, it has become common to *re-process* seismic data acquired in earlier years, creating new opportunities for exploration that could not originally be derived from the 2D data. Processing of data can be very expensive and time-consuming, depending on the size of the area surveyed and the amount of data acquire.

Final resulting processed data will be interpreted by the geophysicist or geologist. The collected seismic data will be interpreted and no two experts will interpret data identically. Geology is still a subjective science. Although dry holes have been greatly reduced by seismic technology, they have not been eliminated. The proper interpretation of seismic survey data is a critical step in the process of selecting a suitable location for drilling of an exploration oil and gas well.



Plate 2.3: Exaple of the conaterised field-based data processing facility and supporting services that will be avaiable for the entire durataion of the proposed 2D seimsic survey operations (Source: www.polarisexplorer.com).

2.4 Logistics and Resources

2.4.1 Overview

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

2.4.2 Fly Camp Site

A temporary survey campsite will be created within each survey block area. The temporary camp si6tes will be setup at suitable locations within the survey area and at strategic line intersections. The size of the exploration camp will be of very limited footprints and will be in form of containerised self-contained cabins. The following are some of the key considerations that shall be considered when selecting camp site areas:

- ❖ The creation of a camp site shall be undertaken with the permission of the traditional authority and the local headmen and owner of the land.
- ❖ The camp site shall not be created too close to the local settlements in order not to have too much interaction with the local community.
- ❖ No big trees shall cut around the selected camp areas.

- ❖ The camp sites shall be selected in abandoned previous cleared fields in order not to disturb pristine areas.
- ❖ The camp site shall be equipped with all the facilities and services including water supply and chemical toilets.

The EIA and EMP will assess any likely impacts that the camp site may have on the receiving environment.

2.4.3 Lines Widening / Clearing

The proposed survey will be undertaken along the already existing roads and tracks. A typical survey track will need a space opening along the survey line (track) of about three meters (3 m) wide. Wherever possible line clearance will take advantage of existing access that will allow close placement of receivers and source points to the pre-plot designated locations.

Following ReconAfrica's guidelines for offsetting source points priority will be to minimise bush cutting and offset points to clear locations. In the case of Receiver points also meander the line to positions that require minimal line clearing. Layout crews will be equipped with pangas if line clearing is needed.

This is a benefit for all stakeholders as we lessen the impact and damage costs associated with line widening. However, if requested by the local community / stakeholders to clear and widen any given track that we may be using in conducting the survey, this will be undertaken within the framework of Corporate Social Responsibility (CSR).

Supervision of line clearance equipment operators will be managed by the Survey Coordinator and assisted by a Surveyor experienced in the operation of GPS/ LIS (Low Impact Seismic) methodology.

2.5 Vibration, Noise and Dust

2.5.1 Variations

Ground motion caused by the vibration from seismic survey is generally barely perceivable. The further away you are from the vibrating source, the less you would feel the vibration (Teasdale *et al*, 2006). According to Teasdale *et al*, (2006), common household activities such as hammering a nail into a wall would cause more vibration to a house than a typical larger vibroseis truck operating in the area.

2.5.2 Noise and Dust

The following are possible sources of air and dust pollution that shall be evaluated further in the EIA and EMP process:

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

2.6 Health, Safety and Environment

2.6.1 Operational Manuals and Policies

The Contractor will prepare a comprehensive Health, Safety and Environment (HSE) operational standards, manuals, and policies for approval by the ReconAfrica. The HSE framework will link directly to the EMP framework covering the following areas:

- ❖ Bridging Document.

- ❖ HSE Management Manual.
- ❖ Project HSE Plan.
- ❖ Waste Management Plan.
- ❖ Journey Management Plan.
- ❖ Grievance Mechanism, and.
- ❖ Cultural Heritage Procedure.

3. LEGISLATIVE FRAMEWORK

3.1 Overview

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

3.2 Key Applicable Legislation

3.2.1 Petroleum (Exploration and Production) Legislation

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

- (i) Petroleum (Exploration and Production) Act, 1991 (Act 2 of 1991).
- (ii) Petroleum Laws Amendment Act, 1998 (Act 24 of 1998).
- (iii) Petroleum Taxation Act, 1991 (Act 3 of 1991).
- (iv) 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.
- (iii) Petroleum Production Licence (PPL): A production licence allows its holder to exclusively carry-on production operations on the block(s) to which that licence relates and to sell or dispose of petroleum recovered within such block(s) and any other activities as stipulated under subsections 39-43 of the Act. Only one (1) production License has so far been issued in Namibia covering the Kudu Gas field situated offshore in the Orange Basin near the border between Namibia and South Africa.

ReconAfrica is holding a PEL granted under Section 22-28 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.

3.2.2 Processing of Applying for a PEL and the Petroleum Agreement (PA)

In the absence of an auctioning licensing regime process, any individual or entity can submit an application for a Reconnaissance or Exploration Licences to the Ministry of Mines and Energy (MME) and such an application for a license may be granted subjected to the terms and conditions as stipulated in the Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991). The first step before an application can even be prepared and submitted to the Ministry of Mines and Energy, an applicant will need to develop a clear regional and local theoretical hydrocarbon model centred on a fully or partially known or assumed knowledge-base with key boundary conditions that must be tested and validated during the exploration process of building the knowledge-base. An application is often prepared by a technical team comprising Geological/ Petroleum Consultants with full technical and financial knowledge about petroleum exploration operations, regional and local geology and possible petroleum systems in Namibia.

An application will usually detail the proposed theoretical hydrocarbon model with key boundary conditions and provides a detailed process by which the proposed theoretical hydrocarbon model is going to be validated and this process is called exploration programme with detailed budget breakdowns. The cost for preparing such an application by the Consultants can be as high as USD10, 000.00 or more and this cost excludes technical data sets that must be purchased from the Government and sold in USD. Depending on the size of the license area, existing data set costs can be as high as USD50, 000.00. There is zero guarantee of recovering the cost of preparing the application and chance of the application being granted once submitted to the Government. Following the lodgement of such an application to the Ministry of Mines and Energy, and the payment of the non-refundable fee of N\$30, 000.00 per application, a standard Model Petroleum Agreement (MPA) is given to the applicant if the application has been formally accepted by the Government (Ministry of Mines and Energy). The MPA is usually reviewed by the technical, financial and legal teams from both the applicant and the Government of Namibia.

Once a date for negotiating the Petroleum Agreement (PA) has been agreed, the technical, financial and legal teams from the applicant and the Government of Namibia meet to negotiate the terms and conditions of the PA covering exploration and possible production conditions in an event of a commercial discovery. The applicant will be required to lodge a guarantee against any non-performance related to the committed exploration activities and expenditure with respect to the committed exploration activities and expenditures. The exploration activities and expenditures guarantee are usually in the range of 10% of the exploration budget. Under Section 13 of the Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991), the Minister of Mines and Energy is required to enter into a Petroleum Agreement with an applicant for a petroleum exploration license before he/she grants such license. Once the Petroleum Agreement has been agreed and license annual fees charged between N\$60.00 – N\$150 per square kilometre which is about N\$650, 000.00 for an average Degree Square Block as well as a mandatory annual contribution of around N\$1.2 million to the Petroleum Training and Education Fund (PetroFund) are paid, a Petroleum Exploration

License is granted to the applicant by the Minister of Mines and Energy in accordance with the provisions of the Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991) and the PA. Finally, a Joint Operating Agreement (JOA) with NAMCOR (State Owned Company) or any other joint venture partner/s participating in the license is negotiated and the proposed exploration activities aimed at testing and validating the developed theoretical hydrocarbon model can now be implemented and monitored by the Ministry of Mines and Energy with annual reporting through a Technical Advisory Committee (TAC).

PetroFund was formed in 1993 in order to offer training in fields of science and information technology through scholarships and support education institution building (www.petrofund.org). The PetroFund provides bursaries and scholarships supports to a total of seventy (70) students every year to study Engineering, Geology, Education (Math and Science), Economics, Law and Computer Science at local, regional and international universities. This is made possible because of the contributions being made by oil and gas exploration companies that continue to undertake petroleum exploration activities in Namibia. The PetroFund is one of the vital and well-funded national financial support systems which is now being threatened by opportunistic Environmental Messiahs trying to champion unfounded ecosystem destruction with no knowledge on how the whole local, regional and global petroleum licensing, exploration, production operations, capital and operational global markets fund raising business actually operates and is benefiting disadvantaged Namibians who do not have the clique, class, ideology, privileges and patronage prevalent in some of the so called environmental non-profits outfits and movements

3.2.4 Key Important Clauses of a Petroleum Agreement

3.2.4.1 Overview

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

The Petroleum Agreement makes provision for the PEL holder to commit to a minimum exploration work program as stated in the initial application. The Government often negotiates specially tailored exploration work programs for each PEL as may be applicable. The Petroleum Agreement also provides for the second and third tier rates of the Additional Profits Tax and the Training and Education Fee and the negotiated figures on these items are provided into the relevant clauses in the Petroleum Agreement. The Petroleum Agreement sets out the procedure to be followed by a licensee on discovery of petroleum. The licensee is forthwith to inform the Commissioner for Petroleum Affairs and then to evaluate the discovery to determine whether it is of potential commercial interest. If it is, the licensee has to take steps to appraise the discovery in accordance with an appraisal program in conformance with the requirements of the Petroleum Agreement. In an event of a commercial discovery expected that implementation of the appraisal program should be completed within two years although upon good cause shown to the Commissioner, he may extend the period.

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

3.2.4.2 Petroleum Agreement Environmental Protection Clause 11

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

- 11.1 The Minister and the Company concede that Petroleum Operations will cause some impact on the environment in the Licence Area.
- 11.2 The Company shall-
 - (a) conduct its Petroleum Operations in a manner likely to conserve the natural resources of Namibia and protect the environment.
 - (b) employ the best available techniques in accordance with Good Oilfield Practices for the prevention of Environmental Damage to which its Petroleum Operations might contribute and for the minimization of the effect of such operations on adjoining or neighbouring Lands, and.
 - (c) implement the proposals contained in its Development Plan regarding the prevention of pollution, the treatment of wastes, the safeguarding of natural resources and the progressive reclamation and rehabilitation of Lands disturbed by Petroleum Operations.
- 11.3 The Company undertakes for purposes of this Agreement to take all reasonable, necessary, and adequate steps in accordance with Good Oilfield Practices to minimize Environmental Damage to the Licence Area and adjoining or neighbouring Lands.
- 11.4 If the Company fails to comply with the terms of clause 11.3 or contravenes any law on the prevention of Environmental Damage and such failure or contravention results in any Environmental Damage, the Company shall take all necessary and reasonable measures to remedy such failure or contravention and the effects thereof.
- 11.5 If the Minister has reason to believe that any works or installations erected by the Company or any operations carried out by the Company are endangering or may endanger persons or any property of any other person or is causing pollution or is harming wildlife or the environment to a degree which the Minister deems unacceptable, the Minister may require the Company to take reasonable remedial measures within such reasonable period as may be determined by the Minister and to take reasonable and appropriate steps to repair any damage to the environment. If the Minister deems it necessary, he may require the Company to discontinue Petroleum Operations in whole or in part until the Company has taken such remedial measures or has repaired any damage.
- 11.6 The measures and methods to be used by the Company for purposes of complying with the terms of clause 11.3 shall be determined in timely consultation with the Minister upon the commencement of Petroleum Operations or whenever there is a significant change in the scope or method of carrying out Petroleum Operations, and the Company shall take into account the international standards applicable in similar circumstances and the relevant environmental impact assessment studies carried out in accordance with clause
- 11.7. The Company shall notify the Minister in writing of the nature of the measures and methods finally determined by the Company and shall cause such measures and methods to be reviewed from time to time in view of prevailing circumstances.

- 11.7 The Company shall cause a person or persons, approved by the Minister on account of their special knowledge of environmental matters, to carry out two environmental impact assessment studies, in order
- (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 be followed in order to minimise Environmental Damage and shall include, but not be limited to-
- (a) Access cutting.
 - (b) Clearing and timber salvage.
 - (c) Wildlife and habitat protection.
 - (d) Resource protection.
 - (e) Fuel storage and handling.
 - (f) Use of explosives.
 - (g) Camps and staging areas.
 - (h) Liquid and solid waste disposal.
 - (i) Cultural and archaeological sites.
 - (j) Selection of drilling sites.
 - (k) Terrain stabilisation.
 - (l) Protection of freshwater horizons.

- (m) Blowout prevention plan.
- (n) Combating oil spills.
- (o) Flaring during completion and testing of gas and oil wells.
- (p) Well abandonment.
- (q) Rig dismantling and site completion.
- (r) Reclamation for abandonment, and
- (s) noise control.

11.11 The Company shall ensure-

- (a) that Petroleum Operations are carried out in an environmentally acceptable and safe manner consistent with Good Oilfield Practices and that such operations are properly monitored.
- (b) that the pertinent completed environmental impact assessment studies are made available to its employees and to its contractors to develop adequate and proper awareness of the measures and methods of environmental protection to be used in carrying out its Petroleum Operations, and.\
- (c) that any agreement entered between the Company and its contractors relating to its Petroleum Operations shall include the terms set out in this Agreement and any established measures and methods for the implementation of the Company's obligations in relation to the environment under this Agreement.

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

11.13 In the event of-

- (a) an emergency or accident arising from Petroleum Operations affecting the environment, the Company shall forthwith notify the Minister accordingly.
- (b) any fire or oil spill, the Company shall promptly implement the relevant contingency plan.
- (c) any other emergency or accident arising from the Petroleum Operations affecting the environment, the Company shall take such action as may be prudent and necessary in accordance with Good Oilfield Practices in such circumstances.

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

11.15 If the Company or the operator for the Company has already completed and submitted to the Government reports on the studies referred to in clause 11.8 for a previous

Exploration Licence held in Namibia in the 5-year period preceding the application for this Exploration Licence and those studies either

- (a) are sufficiently broad ranging to encompass clearly the present Licence Area, or
- (b) do not encompass the present Licence Area but a baseline study and environmental impact assessment study have been submitted by the holder of an Exploration Licence covering an area near the present Licence Area the Company may in a case falling within (a) above, submit the reports on the studies for such previous Licence in fulfilment of the requirements of clauses 11.7 and 11.8 relating to exploration drilling and, in a case falling within (b) above submit such environmental impact assessment submitted by the said holder of an Exploration Licence, with any modifications which the Company wishes to make provided that:
 - (i) In response to a written request from the Company, the Minister approves in writing the course of action selected from (a) or (b) above.
 - (ii) In response to a written request from the Company directed through the Ministry of Mines and Energy, the Ministry of Environment, Tourism and Forestry, the Ministry of Works, Transport and Communication and the Ministry of Health and Social Services also approve in writing the course of action selected from (a) or (b) above.
 - (iii) The company that carried out the baseline study and environmental impact assessment study which are to be submitted in terms of (b) above agrees to this course of action.
 - (iv) The baseline study and the environmental impact assessment study submitted in terms of (b) above encompass the present Licence Area.
 - (v) Fluids, muds and chemicals to be used during drilling are the same as those used in the Exploration Licence covered by the environmental impact assessment study submitted.
 - (vi) Any other special studies relevant to an environmental impact assessment of the effect of drilling on the environment in the present Licence Area as may be required by the Minister are carried out and the results thereof together with plans for mitigating actions be submitted in the form of reports to the Government. A minimum of 12 copies of these reports are to be submitted.
 - (vii) The results of the resubmitted environmental impact assessment study as well as the studies conducted under (v) above are taken into account in preparing all relevant drilling management, waste management and contingency plans relating to the exploration drilling stage.
 - (viii) An amount equal to half the average cost of the three most recent baseline and environmental impact assessment studies complying with the requirements of the first of the studies in clause 11.7 for offshore oil exploration in Namibia or such other amount as may be agreed between the Parties is paid to the National Petroleum Corporation of Namibia (NAMCOR). This money shall be used by NAMCOR in accordance with the principles laid out in Annexure 7 in order to collect offshore environmental data relevant to oil exploration and production in Namibia. Projects to be undertaken by NAMCOR in this connection shall be decided upon in consultation with the oil exploration companies operating in Namibia and with the Ministry of Environment, Tourism and Forestry.

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

- (a) subject to clause 17, remove or otherwise deal with, as directed by the Minister in consultation with the Minister or Ministers responsible for environment, fisheries and finance, all equipment and installations from such Licence Area or relinquished area to the extent and in the manner agreed with the Minister in terms of the Decommissioning Plan approved by the Minister pursuant to s.68A(2) of the Petroleum Act.
- (b) subject to clause 17, remove, or otherwise deal with, as directed by the Minister in consultation with the Minister or Ministers responsible for environment, fisheries and finance, all installations, equipment, pipelines, and other facilities erected or used outside the Licence Area for the petroleum operations. and
- (c) perform all necessary Site Restoration activities in accordance with Good Oilfield Practices and shall take all other action necessary to prevent hazards to human life or to the property of others or the environment.

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

3.3 Other Key Applicable Legislation

3.3.1 Environmental Management Legislation

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

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

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

3.3.2 Communal Land Rights

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

Land Boards. to provide for the powers of Chiefs and Traditional Authorities and boards in relation to communal land. and to make provision for incidental matters. However, communal land is still owned by the State with the allocation of user rights delegated to the traditional authority.

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

3.3.3 Water Legislation

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

3.3.4 Atmospheric Pollution Prevention Legislation

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

3.3.5 Labour, Health and Safety Legislations

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.

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

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

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

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

3.3.7 Summary of Applicable National Legislations

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

- ❖ Namibian Constitution Articles 91(c) and 95.
- ❖ 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).
- ❖ Forestry 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).

3.4 Regulatory Agencies and Permits Register

3.4.1 Key Regulatory Permits and Agencies

Government agencies with permits responsibilities over the proposed project activities are shown in Table 3.1. Table 3.2 shows the relevant permits / licenses required with respect to the proposed 2D seismic survey. Namibia only has standards and guidelines with respect to the freshwater and wastewater and lacks gaseous and noise limits. The comparative water quality guideline is shown in

Table 3.3. The industrial effluent likely to be generated by the proposed operations if any, must comply with provisions of the Government Gazette No 217 dated 5 April 1962 (Table 3.4).

Table 3.1: Government agencies with permits responsibilities over the proposed project activities.

AUTHORITY	TYPE OF AUTHORISATION
Office of the Environmental Commissioner (OEC), Ministry of Environment 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 Forestry	The Directorate of Resource Management within the Department of Water Affairs (DWA) at the MAWF is currently the lead agency responsible for management of surface and groundwater utilisation through the issuing of abstraction permits and waste water disposal permits. DWA is also the Government agency responsible for water quality monitoring and reporting. The National Botanical Research Institute's (NBRI) mandate is to study the flora and vegetation of Namibia, to promote the understanding, conservation and sustainable use of Namibia's plants for the benefit of all. The Directorate of Forestry (DOF) is responsible for issuing of forestry permits with respect to harvest, transport, and export or market forest resources.
Kavango West and East Regional Councils	Overall responsibility of management of regional land resources and allocation of communal land user rights as may be required by the proposed project. Any Lease Agreement or surface land user rights in Communal Land must be approved by the Minister of Urban and Rural Development
Kavango West and East Regions Traditional Authorities	Traditional authorities in Namibia are the custodians of State land falling within authority of the respective tribal authority. With the approval of the Regional Land Boards, traditional authorities are responsible for allocation communal land user rights to the local communities. Consent to use communal land for the proposed 2D seismic survey shall be obtained from the relevant traditional authorities as may be applicable.

Table 3.2: 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 proposed 2D Seismic Survey	Environmental Management Act (2007) and the Environmental Impact Assessment Regulations, 2012	Ministry of Environment, Forestry and Tourism (MEFT)	Still to be Issued
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).	Kavango East and West Regional Councils and Traditional Authorities	Obtain consent. Proposed exploration does not require any Lease Agreement.
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 because the activities will only require the widening the already existing tracks as may be applicable
Removal, disturbance of protected plants.			
Removal, destruction of indigenous trees, bushes, or plants within 100 yards of stream or watercourse.	Forestry Act, 12 of 2001.		

Table 3.3: Comparison of selected guideline values for drinking water quality (after Department of Water Affairs, 2001).

Parameter and Expression of the results			WHO Guidelines for Drinking-Water Quality 2 nd edition 1993		Proposed Council Directive of 28 April 1995 (95/C/13-1/03) EEC	Council Directive of 15 July 1980 relating to the quality intended for human consumption 80/778/EEC		U.S. EPA Drinking water Standards and Health Advisories Table December 1995		Namibia, Department of Water Affairs Guidelines for the evaluation of drinking-water for human consumption with reference to chemical, physical and bacteriological quality July 1991			
			Guideline Value (GV)	Proposed Parameter Value	Guide Level (GL)	Maximum Admissible Concentration (MAC)	Maximum Contaminant Level (MCL)	Group A Excellent Quality	Group B Good Quality	Group C Low Health Risk	Group D Unsuitable		
Temperature	t	°C		-	-	12	25		-	-	-	-	
Hydrogen ion concentration	pH, 25° C	-	R	<8.0	6.5 to 9.5	6.5 to 8.5	10		-	6.0 to 9.0	5.5 to 9.5	4.0 to 11.0	<4.0 to >11.0
Electronic conductivity	EC, 25° C	mS/m		-	280	45	-		-	150	300	400	>400
Total dissolved solids	TDS	mg/l	R	1000	-	-	1500		-	-	-	-	-
Total Hardness	CaCO ₃	mg/l		-	-	-	-		-	300	650	1300	>1300
Aluminium	Al	µ g/l	R	200	200	50	200	S	50-200	150	500	1000	>1000
Ammonia	NH ₄ ⁺	mg/l	R	1.5	0.5	0.05	0.5		-	1.5	2.5	5.0	>5.0
	N	mg/l		1.0		0.04	0.4		-	1.0	2.0	4.0	>4.0
Antimony	Sb	µ g/l	P	5	3	-	10	C	6	50	100	200	>200
Arsenic	As	µ g/l		10	10	-	50	C	50	100	300	600	>600
Barium	Ba	µ g/l	P	700	-	100	-	C	2000	500	1000	2000	>2000
Beryllium	Be	µ g/l		-	-	-	-	C	4	2	5	10	>10
Bismuth	Bi	µ g/l		-	-	-	-		-	250	500	1000	>1000
Boron	B	µ g/l		300	300	1000	-		-	500	2000	4000	>4000
Bromate	BrO ₃ ⁻	µ g/l		-	10	-	-	P	10	-	-	-	-
Bromine	Br	µ g/l		-	-	-	-		-	1000	3000	6000	>6000
Cadmium	Cd	µ g/l		3	5	-	5	C	5	10	20	40	>40
Calcium	Ca	mg/l		-	-	100	-		-	150	200	400	>400
	CaCO ₃	mg/l		-	-	250	-		-	375	500	1000	>1000
Cerium	Ce	µ g/l		-	-	-	-		-	1000	2000	4000	>4000
Chloride	Cl ⁻	mg/l	R	250	-	25	-	S	250	250	600	1200	>1200
Chromium	Cr	µ g/l	P	50	50	-	50	C	100	100	200	400	>400
Cobalt		µ g/l		-	-	-	-		-	250	500	1000	>1000
Copper after 12 hours in pipe	Cu	µ g/l	P	2000	2	100	-	C	TT##	500	1000	2000	>2000
		µ g/l		-	-	3000 ¹	-	S	1000	-	-	-	-
Cyanide	CN ⁻	µ g/l		70	50	-	50	C	200	200	300	600	>600
Fluoride	F ⁻	mg/l		1.5	1.5	-	at 8 to 12 °C: 1.5	C	4	1.5	2.0	3.0	>3.0
		mg/l		-	-	-	at 25 to 30 °C: 0.7	P,S	2	-	-	-	-
Gold	Au	µ g/l		-	-	-	-		-	2	5	10	>10
Hydrogen sulphide	H ₂ S	µ g/l	R	50	-	-	undetectable		-	100	300	600	>600
Iodine	I	µ g/l		-	-	-	-		-	500	1000	2000	>2000
Iron	Fe	µ g/l	R	300	200	50	200	S	300	100	1000	2000	>2000
Lead	Pb	µ g/l		10	10	-	50	C	TT#	50	100	200	>200
Lithium	Li	µ g/l		-	-	-	-		-	2500	5000	10000	>10000
Magnesium	Mg	mg/l		-	-	30	50		-	70	100	200	>200
	CaCO ₃	mg/l		-	-	7	12		-	290	420	840	>840
Manganese	Mn	µ g/l	P	500	50	20	50	S	50	50	1000	2000	>2000
Mercury	Hg	µ g/l		1	1	-	1	C	2	5	10	20	>20
Molybdenum	Mo	µ g/l		70	-	-	-		-	50	100	200	>200
Nickel	Ni	µ g/l		20	20	-	50		-	250	500	1000	>1000
Nitrate*	NO ₃ ⁻	mg/l	P	50	50	25	50		45	45	90	180	>180
	N	mg/l		-	-	5	11	C	10	10	20	40	>40
Nitrite*	NO ₂ ⁻	mg/l		3	0.1	-	0.1		3	-	-	-	-
	N	mg/l		-	-	-	-	C	1	-	-	-	-
Oxygen, dissolved	O ₂	% sat.		-	50	-	-		-	-	-	-	-
Phosphorus	P ₂ O ₅	µ g/l		-	-	400	5000		-	-	-	-	-
	PO ₄ ³⁻	µ g/l		-	-	300	3350		-	-	-	-	-
Potassium	K	mg/l		-	-	10	12		-	200	400	800	>800
Selenium	Se	µ g/l		10	10	-	10	C	50	20	50	100	>100
Silver	Ag	µ g/l		-	-	-	10	S	100	20	50	100	>100
Sodium	Na	mg/l	R	200	-	20	175		-	100	400	800	>800
Sulphate	SO ₄ ²⁻	mg/l	R	250	250	25	250	S	250	200	600	1200	>1200
Tellurium	Te	µ g/l		-	-	-	-		-	2	5	10	>10
Thallium	Tl	µ g/l		-	-	-	-	C	2	5	10	20	>20
Tin	Sn	µ g/l		-	-	-	-		-	100	200	400	>400
Titanium	Ti	µ g/l		-	-	-	-		-	100	500	1000	>1000
Tungsten	W	µ g/l		-	-	-	-		-	100	500	1000	>1000
Uranium	U	µ g/l		-	-	-	-	P	20	1000	4000	8000	>8000
Vanadium	V	µ g/l		-	-	-	-		-	250	500	1000	>1000
Zinc after 12 hours in pipe	Zn	µ g/l	R	3000	-	100	-	S	5000	1000	5000	10000	>10000
		µ g/l		-	-	5000	-		-	-	-	-	-
			P: Provisional R: May give reason to complaints from consumers					C: Current. P: Proposed. S: Secondary. T#: Treatment technique in lieu of numeric MCL. TT##: treatment technique triggered at action level of 1300 u g/l					

Table 3.4: R553 Regional Standards for Industrial Effluent, in Government Gazette No 217 dated 5 April 1962.

Colour, odour and taste	The effluent shall contain no substance in concentrations capable of producing colour, odour or taste	
pH	Between 5.5 and 9.5	
Dissolved oxygen	At least 75% saturation	
Typical faecal coli	No typical faecal coli per 100 ml	
Temperature	Not to exceed 35 °C	
Chemical demand oxygen	Not to exceed 75 mg/l after applying a correction for chloride in the method	
Oxygen absorbed	Not to exceed 10 mg/l	
Total dissolved solids (TDS)	The TDS shall not have been increased by more than 500 mg/l above that of the intake water	
Suspended solids	Not to exceed 25 mg/l	
Sodium (Na)	The Na level shall not have been increased by more than 50 mg/l above that of the intake water	
Soap, oil and grease	Not to exceed 2.5 mg/l	
Other constituents	Residual chlorine	0,1 mg/l as Cl
	Free & saline ammonia	10 mg/l as N
	Arsenic	0,5 mg/l as As
	Boron	1,0 mg/l as B
	Hexavalent Cr	0,05 mg/l as Cr
	Total chromium	0,5 mg/l as Cr
	Copper	1,0 mg/l as Cu
	Phenolic compounds	0,1 mg/l as phenol
	Lead	1,0 mg/l as Pb
	Cyanide and related compounds	0,5 mg/l as CN
	Sulphides	1,0 mg/l as S
	Fluorine	1,0 mg/l as F
	Zinc	5,0 mg/l as Zn

3.5 International Standards, Treaties and Protocols

3.5.1 Applicable International Standards

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

The only key missing components to the regulatory frameworks in Namibia are benchmarks, limits, standards, and guidelines with respect to gaseous, liquid, and solid emissions. However, in the absence of national gaseous, liquid, and solid emission limits for Namibia, the proposed project shall target the Multilateral Investment Guarantee Agency (MIGA) gaseous effluent emission level and liquid effluent emission levels (Table 3.5). Noise abatement measures must target to achieve either the levels shown in Table 3.6 or a maximum increase in background levels of 3 dB (A) at the nearest receptor location off-site (MIGA guidelines).

Table 3.5: Liquid effluent emission levels (MIGA /IFC).

Pollutant	Max. Value
pH	6-9
Total suspended solids	50 mg/l
Total metals	10 mg/l
Phosphorous (P)	5 mg/l
Fluoride (F)	20 mg/l
Cadmium (Cd)	0.1 mg/l

Table 3.6: Noise emission levels (MIGA /IFC).

	Maximum Allowable Leq (hourly), in dB(A)	
Receptor	Day time (07:00 – 22:00)	Night time (22:00 – 07:00)
Residential, institutional, educational	55	45
Industrial, commercial	70	70

3.5.2 International and Regional Treaties and Protocols

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

- ❖ The Paris Agreement, 2016.
- ❖ Convention 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.

3.5 Recommendations on Regulatory Framework

The regulatory framework with respect to the proposed 2D seismic survey shall be reviewed during the EIA and EMP stages. The proposed 2D seismic survey operation shall meet all the applicable national legislation, regulations, standards, and guidelines as well as international and regional regulatory frameworks, standards, treaties, and protocol as well as the International Association of Geophysical Contractors (IAGC) industry standards for conducting onshore seismic survey operations. The IAGC is the global trade association representing all segments of the geophysical and exploration industry (www.iagc.org). The IAGC provides guidance materials and industry best practices for land seismic operations.

It is hereby recommended that the Proponent shall comply with the provisions of all relevant and applicable national regulatory frameworks and requirements in Namibia. Local community, cultural, religious, and traditional practices as well as fair labour relations and local hire shall always be observed with continuous engagement with the traditional authorities and Regional Councils as may be applicable.

4. RECEIVING ENVIRONMENT

4.1 Physical Geography

The local landscape is characterised by gentle undulating sandy topography of the densely forested / vegetated sandy Kalahari Dune Belt. The general topographic setting of the profiles / survey line trends varies from 1130 to 1173 meters above mean sea level (amsl) for the topographically lower and higher laying areas respectively.

Some parts of the targeted survey area are fenced under the communal land use / government resettlement programme.

4.2 Climate and Land Use

4.2.1 Climatic Components

The proposed project area is located in the north central part of Namibia with daytime warm to hot temperatures throughout the year, while the nights are mild to cool. The mean annual rainfall is highly variable between 400 and 600 mm per year (Fig. 4.1).

The distribution of rainfall is extremely seasonal with almost all the rain falling in summer - from October to April with occasional with mean annual gross evaporation is between 2600-2800 mm (Fig. 4.1).

4.2.2 Land Use

The land uses in the general area is mainly communal / subsistence farming comprising cattle, donkeys, seasonal crop farming, grass, and wood / timber harvesting. Subsistence seasonal (January to April) crop farming of millet and maize are centred on widely spaced communal villages especially within and along the Omatako and all associated Ephemeral Rivers channels, plains, and depressional topographically low area.

The villages are also centred around communal water points or near schools or rural clinics where water is readily available. The key farming areas falls within the undulating and depressional zones of the east-west trending Kalahari Dunes where local soils are slight fertile.

Forestry clearing for subsistence agriculture is dominates in the region with slash and burn being used which sometimes run out of control and destroys larger portions of the forest annually.

The following is the summary of some of the common general threats to the natural environment and habitats of the general project area:

- (i) Accelerated allocation of communal leaseholds resulting in forestry clearing.
- (ii) Subsistence communal crop framing centred on forestry clearing, slash and burn practices.
- (iii) Timber and wood harvesting, and.
- (iv) Overgrazing due to increased number of animals.

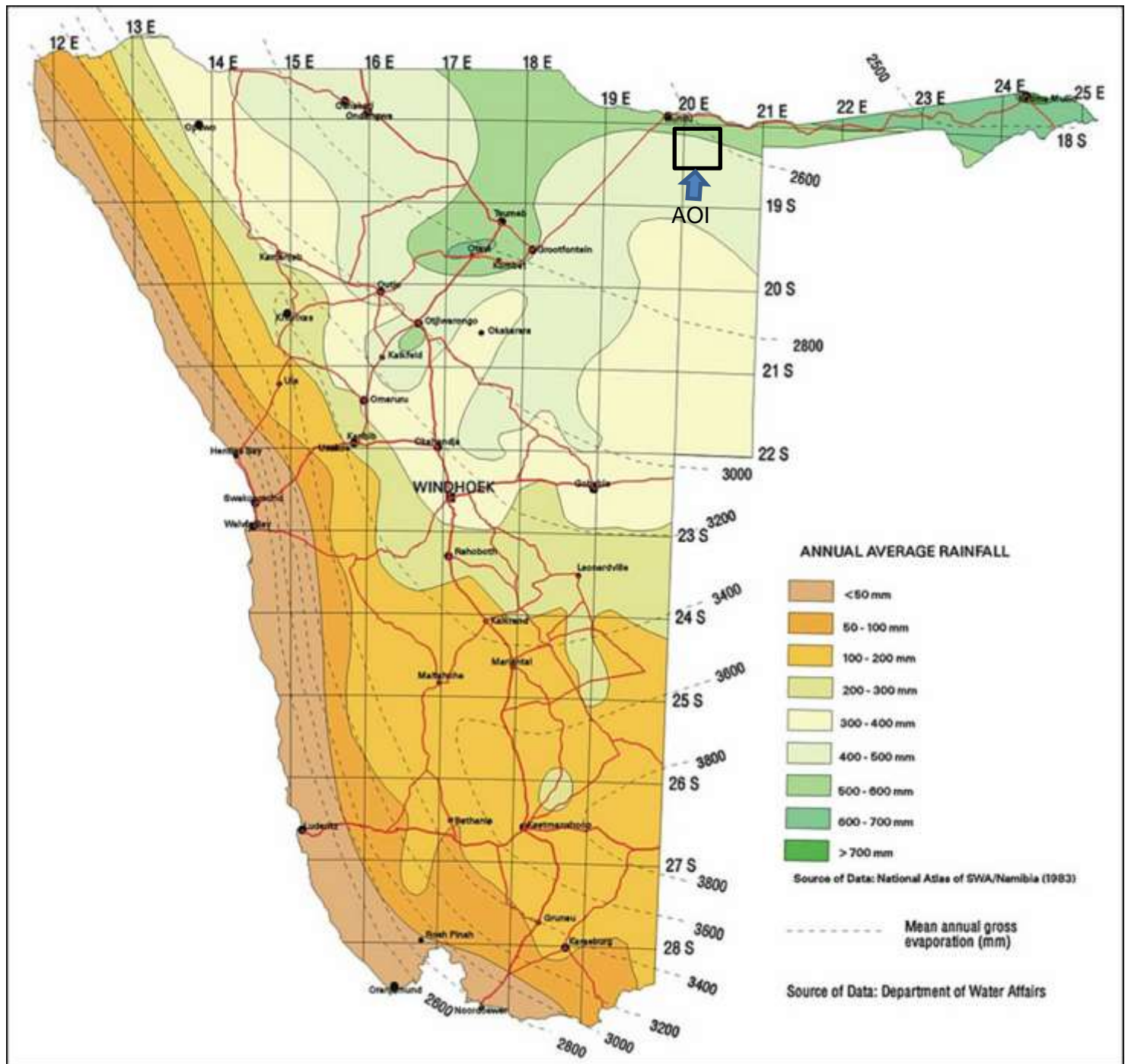


Figure 4.1: Regional climatic settings of the project area, PEL 73.

4.3 Fauna and Flora Diversity

4.3.1 Overview

A comprehensive literature study (desktop) of the vertebrate fauna (i.e. amphibians, birds, mammals and reptiles) and flora (i.e. larger trees/shrubs [$>1\text{m}$ in height] and grasses) expected to occur in the general Kavango Basin – Blocks 1819 and 1820 [PEL 73] – was conducted during December 2018. This was followed up by fieldwork conducted in November and December 2020 (current study) to determine the effect that the proposed ground seismic survey may have on the bio-physical environment (vertebrate fauna and flora) within the development area and immediate surroundings and especially along the proposed seismic survey lines.

This literature review was to determine the actual as well as potential vertebrate fauna and flora associated with the general area commonly referred to as the Tree Savanna and Woodlands (Northern Kalahari) (Giess 1971) or a combination of North-eastern Kalahari Woodland; Eastern Drainage; Northern Kalahari and Omatako Drainage, with the North-eastern Kalahari Woodland being the dominant vegetation type (Mendelsohn *et al.* 2002). The vegetation structure is classified as broadleaved woodlands (Mendelsohn *et al.* 2002).

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

It is estimated that at least 67 species of reptile, 32 amphibian, 116 mammal and 210 bird species (breeding residents) are known to or expected to occur in the general Kavango East and West regions of the proposed project area.

According to Maggs (1998) there are approximately 4344 higher plant species with the most species being within the grasses (422), composites (Asteraceae) (385), legumes (Fabaceae) (377) and figs (Mesembryanthemaceae) (177), recorded from Namibia. Total species richness depends on further collecting and taxonomic revisions. High species richness is found in the Okavango, Otavi/Karsveld, Kaokoveld, southern Namib and Central Highland (Windhoek Mountains) areas. Endemic species – approximately 687 species in total – are mainly associated with the Kaokoveld (north-western) and the succulent Karoo (south-western) Namibia. The major threats to the floral diversity in Namibia are:

- ❖ Conversion of the land to agriculture (with associated problems), and.
- ❖ Poorly considered development (Maggs 1998, Mendelsohn *et al.* 2002).

A large variety of deciduous trees are found in the Savannah and Woodlands [Northern Kalahari area] vegetation type. The grasses are usually hard and unpalatable in this area with *Antheophora pubescens*, *Brachiaria nigropedata* and *Schmidtia pappophoroides* viewed as the climax grasses in the open savannah areas (Giess 1971).

The general area has a “medium” plant diversity of between 300-399 species although the Okavango River to the north has a higher diversity (400-499 species). The endemism is viewed as “low” throughout with no species viewed as endemic (Mendelsohn *et al.* 2002). Simmons (1998a) puts the plant endemism in the general area at between 1-10 species depending on the locality. These estimates are limited to “higher” plants as information regarding “lower” plants is sparse. The greatest variants affecting the diversity of plants are habitat and climate with the highest plant diversity generally associated with high rainfall areas. Pockets of high diversity are found throughout Namibia in “unique” habitat – often transition zones – e.g. mountains, inselbergs, etc. – and riparian areas.

Furthermore, Mendelsohn *et al.* (2002) views the overall plant production as “very to extremely high” while the variation in plant production is mostly “very low to low” (0-10%) although dependant on the location. The grazing potential is viewed as “low to average” in the general area while the browse potential is viewed as “good”. Bush thickening (encroachment) is not viewed as problematic in the general area (Bester 1996, Cunningham 1998). The risk of farming is viewed as “low” with the tourism potential viewed as “average to high” (Mendelsohn *et al.* 2002).

It is estimated that at least 107 species of larger trees and shrubs (>1m in height) and up to 111 species of grasses are known to or expected to occur in the general area, none of which are viewed as endemic species.

4.3.2 Important Fauna and Flora Species

4.3.2.1 Reptiles

The most important species are viewed as the 2 endemics (*Ichnotropis grandiceps* and *Lygodactylus bradfieldi*), 3 species classified as rare (*Lycophidion multimaculatum*, *Psammophis jallae*, *Causus rhombeatus*) and 6 species classified as vulnerable (*Stigmochelys pardalis*, *Psammobates oculiferus*, *Kinixys spekii*, *Python natalensis*, *Varanus albigularis*, *Varanus niloticus*) from the general area. Furthermore, *Ichnotropis grandiceps*, is also classified as data deficient by the IUCN (2020), supporting its importance.

4.3.2.2 Amphibians

The most important species from the area is the giant bullfrog (*Pyxicephalus adspersus*) with “population decreasing” according to the IUCN (2020) as it is consumed as food throughout its range.

4.3.2.3 Mammals

The most important species from the general area are probably those classified as rare (*Nycteris hispida*, *Kerivoula argentata*, *Kerivoula lanosa*, *Mastomys shortridgei*, *Civettictis civetta*, *Paracynictis selousi*) and endangered (*Lycaon pictus*, *Lutra maculicollis*, *Equus (burchellii) quagga*) under Namibian legislation and those classified by the IUCN (2020) as endangered (*Lycaon pictus*), vulnerable (*Loxodonta africana*, *Smutsia (Manis) temminckii*, *Acinonyx jubatus*, *Panthera pardus*, *Panthera leo*, *Hippopotamus amphibious*, *Giraffa camelopardalis*) and near threatened (*Hipposideros vittatus*).

However, some of the above species – e.g. other, hippo, etc. – are only associated with the Okavango River and not linked to the key exploration areas of interest. The most important species expected to occur in the general area would be the African wild dog (*Lycaon pictus*) and pangolin (*Smutsia (Manis) temminckii*).

4.3.2.4 Birds

The most important species are viewed as those classified as endangered (hooded vulture, white-backed vulture, tawny eagle, martial eagle, bateleur, southern ground-hornbill), vulnerable (secretarybird, white-headed vulture, lappet-faced vulture and) and near threatened (marabou stork, peregrine falcon, kori bustard) from Namibia (Simmons *et al.* 2015) as well as those classified by the IUCN (2020) as critically endangered (hooded vulture, white-headed vulture, white-backed vulture), endangered (lappet-faced vulture), 4 vulnerable (secretarybird, tawny eagle, martial eagle, southern ground-hornbill) and near threatened (bateleur, kori bustard).

4.3.2.5 Trees and Shrubs

The most important species expected to occur in the general area are *Baikiaea plurijuga* (Protected F#; LR-nt), *Burkea africana* (Protected F#), *Guibourtia coleosperma* (Protected F#), *Dialium englerianum* (Protected F#), *Philenoptera violacea* (Protected F#), *Pterocarpus angolensis* (Protected F#; LR-nt), *Schinziophyton rautanenii* (Protected F#), *Sclerocarya birrea* (Protected F#) and various *Strychnos* species (Protected F#).

4.3.2.6 Grass

The grasses commonly used for thatching – *Eragrostis pallens* and *Cymbopogon* species – which also have economic value, are the important grasses in the area.

4.4 Socioeconomic Settings

4.4.1 Kavango West and East Regions

Nkurenkuru is the capital of the Kavango West Region and it's situated about 140 km west of Rundu the regional Capital of Kavango East region. The boundary between Kavango East and West generally follows the Omatoko-Omuramba River.

The Kavango West Region covers an area of 24,591.27 km² and lies directly south of Angola and the Kavango River and east of Ohangwena and Oshikoto Regions, north of Otjozondjupa Region and west of the Kavango East Region. Kavango West Region is subdivided into eight electoral constituencies namely: Kapako, Mankumpi, Mpungu, Musese, Ncamangoro, Ncuncuni, Nkurenkuru, and Tondoro (Annex 3).

Kavango East Region covers an area of 23,987 km² and is bordered by the Kavango West, Otjozondjupa and Zambezi Regions. The constituencies in Kavango East Region include: Rundu Urban, Rundu Rural, Mashare, Mukwe, Ndiyona and Ndonga Linena.

Both regions and the project area are characterised by an extremely uneven population distribution with high levels of poverty. The interior of the regions are very sparsely inhabited, while the northernmost strip, especially along the Kavango River, has a high population concentration (National Planning Commission, 2012). According to Mendelsohn *et al.* (2006), the general livelihood of the people in the two regions is derived from small-scale agro-pastoralism, supported by fishing along the Okavango River. Overall, subsistence agriculture comprising animal husbandry (cattle and goats), cultivation of millet and maize and timber logging are an integral part of the day to day survival of the rural population within the project.

The following is the summary of the socioeconomic settings of the proposed project area:

- ❖ The population of Ncamangoro Constituency is 7043 people, which is 8.1% people of Kavango West Region. Mashare Constituency has 8885 people, which is 11.2% of Kavango East population.
- ❖ Inter-Census growth rates are 1.6% for Kavango East Region and 0.6% for Kavango West Region.
- ❖ Gender distribution is slightly inclined towards higher female shares. Mashare Constituency had 52% of female and 48% of male population and Ncamangoro Constituency had 51.9% female and 48.1% male population.
- ❖ The population density in both regions is above national average. 6.2 people for km² in Kavango East was and 3.6 people for 1 km² in Kavango West.
- ❖ Inter-census recorded that both Kavango Regions have high proportion of persons with disabilities, particularly high was in Kavango West (7.6%). This is the highest in Namibia. East recorded 6.0% of persons with disabilities.
- ❖ Ncamangoro Constituency falls within the Mbunza Traditional Authority and Mashare Constituency falls within Sambyu Traditional Authority.
- ❖ Rukavango-speaking people constitute the largest language group in Kavango (79.4% of the population), and San constitute 0.4% of the region's population.
- ❖ Mashare Constituency's adult literacy rate stood at 72% and Ncamangoro recorded only 63.3% of people being literate. Literacy rates in both constituencies are not only below their respective regional average rates, but they are among lowest in Namibia.
- ❖ Kavango Regions (East and West) has the largest population of unemployed youth aged 15-35 and the highest unemployment rates. Unemployment in Kavango East is 39.6% and in

Kavango West stands at 36.4 %. Unemployment in Ncamangoro Constituency stood at 52.2%. Unemployment rate for female is higher than for male.

- ❖ Kavango regions have highest incidence of poverty, 53% of all population. Poverty is defined as the number of households who are unable to afford sufficient resources to satisfy their basic needs.
- ❖ The main employment industries in Kavango East and Kavango West is agriculture, forestry and fisheries. Around 45.95% of employed in Kavango East are in the agriculture, forestry and fisheries sector and in Kavango West the share is even larger 80.04%.
- ❖ The Kavango West and East Regions are relatively well covered with a network of roads; unfortunately, most of these roads are gravel or sandy roads that make travel difficult. Kavango East Region has one airport, at Rundu, that accommodates national flights. Several smaller airstrips cater for the tourism sector especially in the eastern part of the region.
- ❖ Nevertheless, people living deep in the interior of both regions are far from social infrastructure, thus access to education and medical treatment is difficult.
- ❖ The communities living in the northern part of the Kavango West and Kavango East Regions along the road from Nkurenkuru to Rundu and Rundu to Divundu road are relatively well connected to the national electricity grid. The remainder of the rural communities situated away from the river and the main road are connected mostly with off-grid facilities that utilise either solar power systems or diesel power systems.
- ❖ The Okavango River is the main source of water for the people living along the river, and for their livestock, whereas villages away from river depend entirely on groundwater from boreholes supplied by MAWLF and in some cases from seasonal pans. The urban areas - settlements and towns are provided with water by the NamWater.
- ❖ The main economic activities of both Kavango Regions are agriculture, mainly small-scale mahangu farming, providing some food self-sufficiency but little food security; aquaculture; timber harvesting; tourism, particularly in Kavango East Region; and sand mining activities.
- ❖ There are a number of community forests within the Kavango East and Kavango West Regions Two (2) community forests in Kavango West and ten (10) community forests in Kavango East. The proposed area is not located within the community forest areas, however the existing roads and tracks to be used for the proposed 2D seismic survey cut across community forestry such as the Gcwatjinga and Mbeyo. Illegal harvesting of timber in Kavango Regions is on rise and attributed to the high demand for timber worldwide, and.
- ❖ Tourism is mainly in Kavango East Region. In Kavango West Region it is limited and undeveloped. Tourism in the Kavango East Region is mostly focused on the eastern part of the region around Divundu, to some extent in the central part of the region next to the Kavango River and in Rundu. This is associated with the fact that most of the biodiversity, wildlife and scenic areas are found in the eastern part of the region. Kavango East Region falls within the Kavango Zambezi Transfrontier Conservation Area (KAZA TFCA).

The EIA and EMP will assess the potential positive and negative impacts and offers enhancement measures for positive impacts such as recruitment of local people along each survey line.

4.5 Subsurface Ground Components

4.5.1 Regional Geology and Petroleum System

The present-day Kalahari Basin owes its origin to the uplift of the Southern Africa continental margin during the break-up of African proto-type continent known as Gondwanaland (Summerfield, 1985); this tectonic event created what is now known as the “The Great Escarpment” by uplifting the Southern African continental margin followed by the down-warping of the continental interior – creating the

Kalahari Basin comprising the Kalahari Group sediments extending over much of Southern Africa (De Swardt and Bennet, 1974 and Fig. 4.2).

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

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

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

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

Reconnaissance Energy Namibia (Pty) Ltd has interpreted high resolution aero magnetic data documenting a very deep untested Kavango Basin with optimal conditions for preserving a thick interval of organic rich marine shales in the lower portion of the Karoo Super Group. Maximum depth to basement is estimated at over 9 kilometres. The company has also completed structural and geological interpretations of magnetic inversion profiles, backfilling the basin with stratigraphic section of Precambrian, Permian, and Cretaceous sediments (Fig. 4.3).

Reconnaissance Energy Namibia (Pty) Ltd.'s interpretation strongly suggests that the formational equivalents to the Lower Ecca Group will be preserved in the untested deeper portions of the Kavango Basin. The company believes that these target sediments lie in a previously unrecognised Karoo Basin along major trans African lineaments that link northeast Namibia to the better-known Karoo rift basins in eastern Africa.

Reconnaissance Energy Namibia (Pty) Ltd.'s geologic team has defined a beneficial structural framework and depositional basin configuration utilising a high-resolution aero-magnetic database. The company has developed a fully integrated structural inversion model for the entirety of the Kavango Basin defining a pull-apart basin with targetable half grabens capable of housing substantial thickness of Karoo-aged sediments and reef-prone Lower Paleozoic Units.

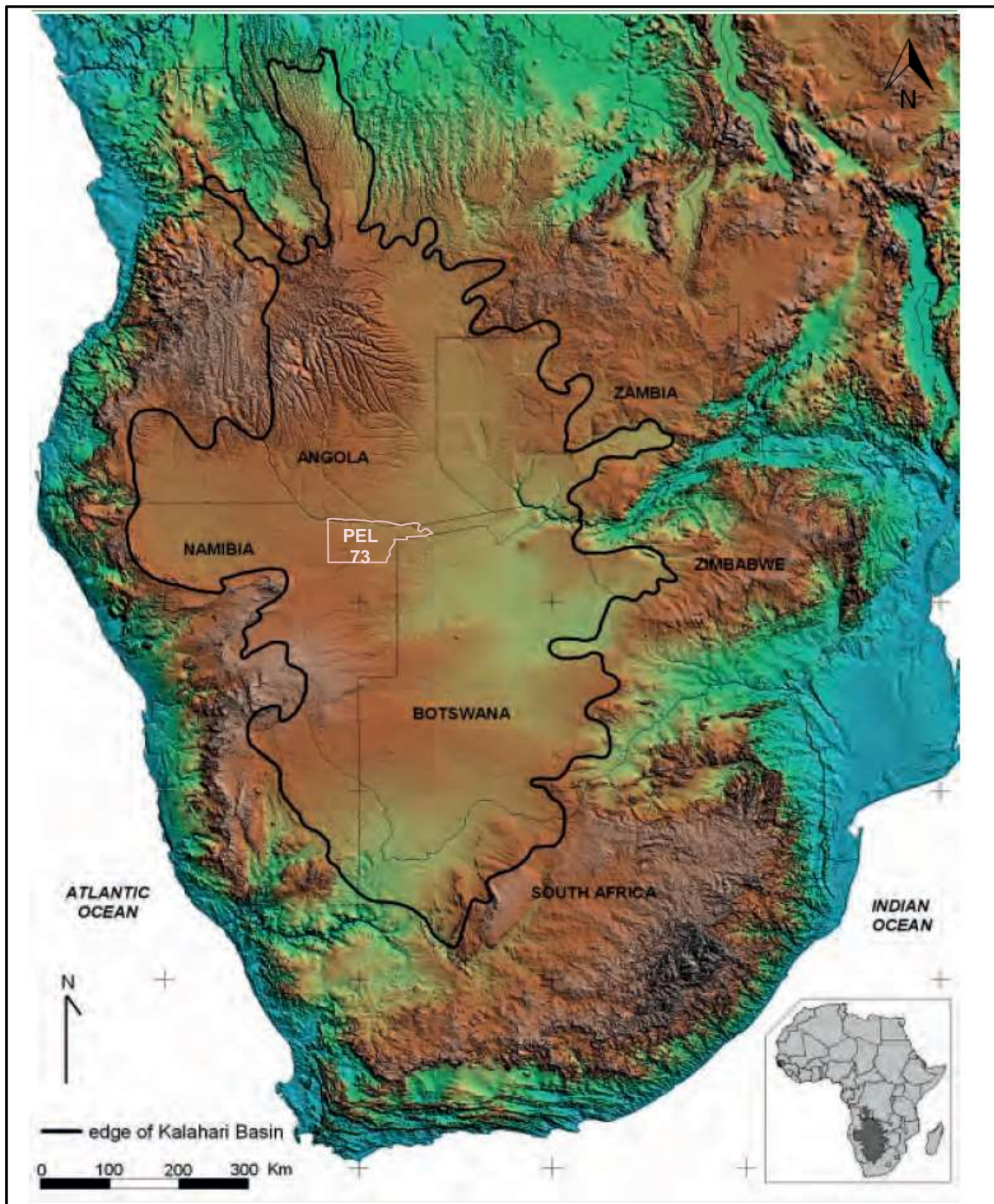


Figure 4.2: Lateral extent of Kalahari Group sediments (Source: Haddon, 2005).

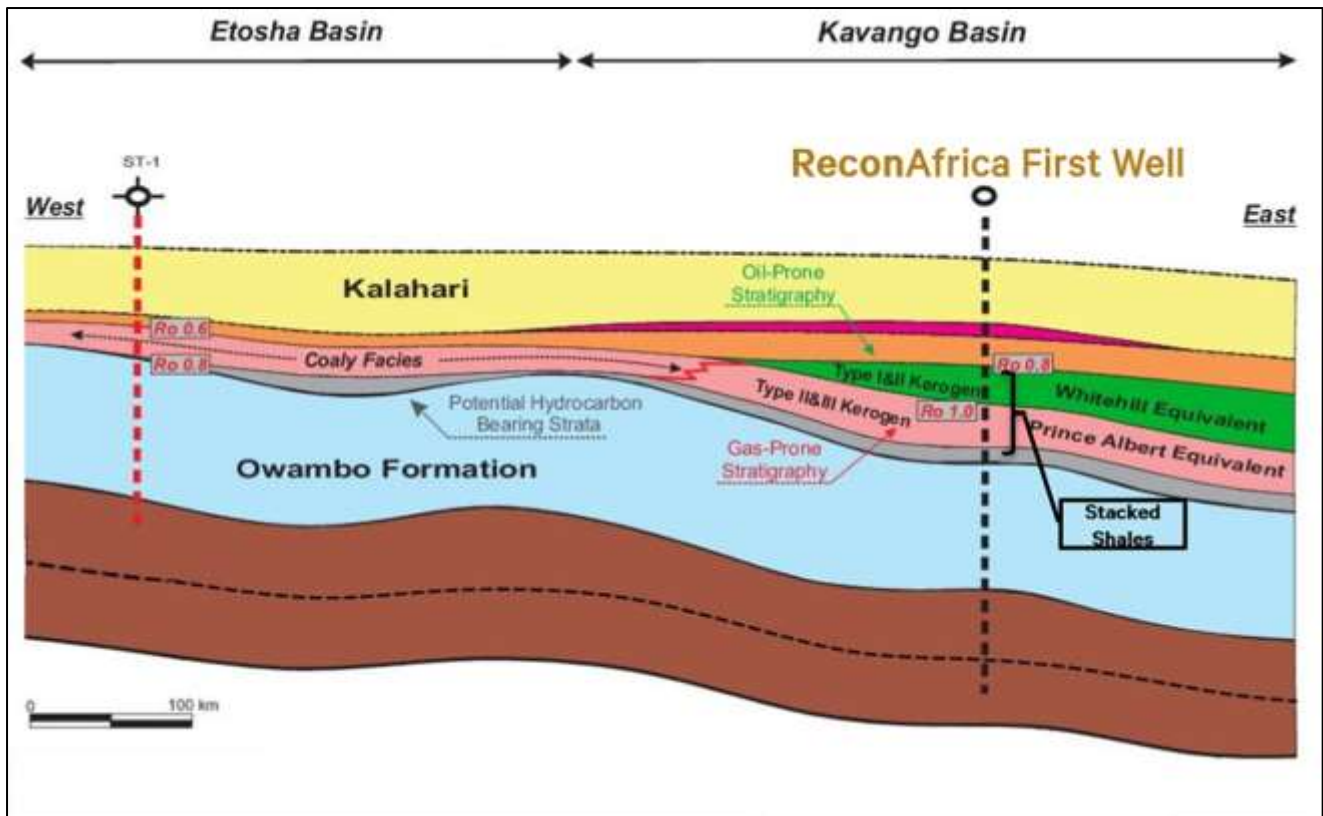


Figure 4.3: 3D model representation of PEL 73 and the Kavango Basin based on the interpretation and integration of the geophysical, structural and geological data sets (Source: Reconnaissance Energy Namibia <http://reconafrika.com>, Accessed June 2019).

4.5.2 Water Resources

4.5.2.1 Surface Water

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

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

The survey area covers three basins, the Kavango 1 and the Kavango 2 dissected by the graben controlled Omatako Basin (Fig. 4.4). In the Kavango 1 Basin streams essentially flow south-north into the Okavango River; deviating from the regional slope and probably emphasizing local structural control, whereas in the Omatako Basin the Omatako River flows north east into the Okavango River. Streams in the Kavango 2 Basin flow along the regional north east slope. It should be noted here that rivers initially follow slope and then adjust to local geologic structure as they incise their beds.

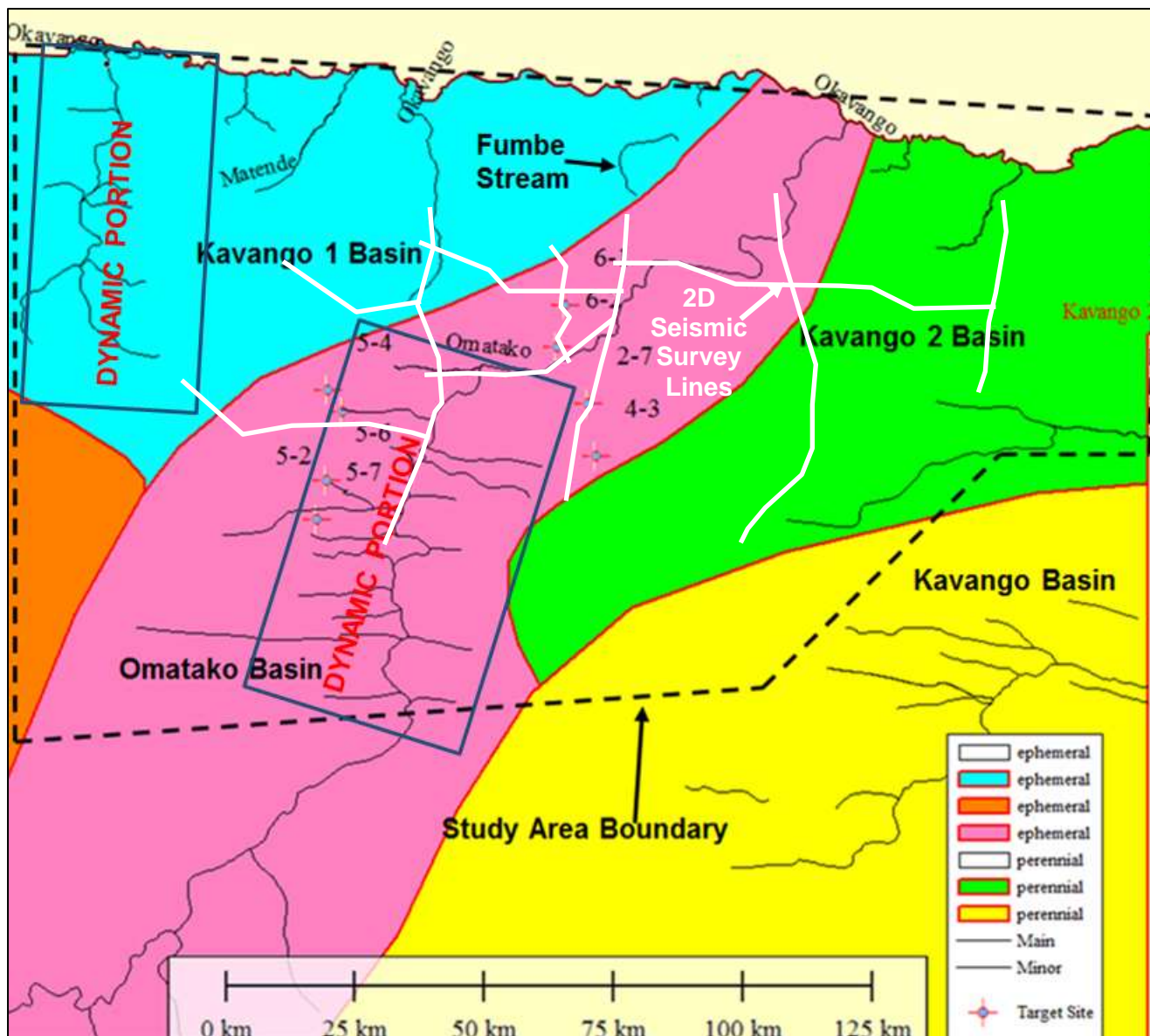


Figure 4.4: Local drainage system of the general area covered by the proposed 2D seismic survey.

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

About stream network density (sum of stream length per unit area of section of basin), km/km^2 the dissected portion of the Omatako Basin's Dd is estimated at 0.033 whereas that of the Mpuku stream is approximately 0.072, meaning that the Mpuku Stream drainage area's runoff potential is relatively two-fold more than that of the dissected portion of the Omatako River. However, it should be qualified here that stream density (Dd) values of less 5 (0.033 for Omatako River, and 0.072 for the Mpuku stream) imply coarse stream texture which is characteristic of dry regions with none perennial flow or flow only during rainy seasons.

These observations allow inference into the dynamic and active drainage portions of the study area. Portions outside the ones marked dynamic are either quiet or relatively less dynamic, and play roles of sediment and run-off accommodation, through flow, and infiltration sites. The two areas marked

dynamic portions in Fig. 4.4 are the relatively dynamic drainage portions of the study area, and it is expected that these are sites of erosion, run-off, and overland flow.

Drainage analysis efficiently links to surface-water Groundwater interaction, therefore the observations presented above offer an opportunity to infer the surface-water Groundwater interaction dynamics of the study area in view of preferential sites, losing or gaining, pathways, infiltration potential, and flow fields.

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

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

The proposed 2D seismic survey operations will be undertaken along existing roads and tracks with little to no interference to surface water system of the area (Plates 1.1 -1.24).

4.5.2.2 Hydrogeology

The geographic coverage and systematic hydrogeological investigations of the Kalahari Group in Namibia is limited to due to two cited factors; namely lack of mineral interests and that the area is sparsely inhabited (Wanke & Wanke, 2007; Jones, 2010).

The first concerted effort to study the hydrogeological potential of the Kalahari Group in general and in the Omatako Basin/graben in particular is that of the CSIR in 1982 when it was realized that Okarakara is becoming a population-growth point. Based on geophysical investigations (vertical electrical sounding) and core drilling of one exploration borehole, CSIR (1982) identified three hydrogeological units in the Kalahari Group; namely the upper, middle and lower Kalahari. Of the three units, the middle Kalahari sandstone was recognized as the most promising aquifer of the three units, whereas the lower Kalahari is reported to be argillaceous and of poor water quality.

Most of the findings of the CSIR (1982) were confirmed by a drilling campaign by the Department of Water Affairs in 1996/1997 (DWA, 1997). Furthermore, DWA (1997) contends that where the saturated thickness of the middle Kalahari is less than 100 m, borehole yields tend to decline with decreasing saturated thickness.

Without ruling out that one consecutive study might have been influenced by the findings of the previous one, Kuells (1998-2000) in his then unfinished PHD study assumed a general concept of the middle Kalahari sandstones as a well-developed aquifer system within the stratigraphy of the Kalahari Group, and goes further to characterize the sandstone as a semi-consolidated to consolidated homogeneous productive aquifer which depends on both diffuse and direct recharge from sub-surface flows and from percolation following good rainfall events respectively. However, and probably influenced by the large geographic scale of his study, Simmonds (1999) contends that the aquifers of the Kalahari Group can be classified as either deltaic or Aeolian; characterizing them as low yielding, very fine sand, silty sand and sandstone aquifers with clayey horizons.

Jones (2010) adds a bit of substance to the nature of the lower Kalahari aquifer beyond what CSIR (1982) contends as argillaceous and describes it as fluvial and lacustrine. This position tallies with that of Thomas and Shaw (1991) in which the lower Kalahari is described as a conglomerate and gravel unit capped by pink to red marls in parts. Furthermore, Thomas and Shaw (1991) distinguish two other units of the Kalahari Group relating to varicoloured sandstone probably equivalent to the middle

Kalahari and another unit starting with widespread calcrete, silcrete and other duricrust; probably signalling the onset of the upper Kalahari group. Jones (2010) relates the later (widespread calcrete and silcrete unit) to the onset of dry conditions and reduced denudation as the hydrological regime became seasonal following original perennial drainage becoming ephemeral and possible fragmentation of the drainage system into closed sub-basins.

Results from recent drilling of six boreholes all of them to a depth of 150 m at Katji na Katji (NamWater, 2018) indicates a consistent stratification of fine sand with clayey horizons in the top 90 m followed either medium sand or sandstone from 90 to 150 m. Where there is fine to medium grained sand occurrence in the bottom 60 m, it would be calcareous on top and clayey at the bottom, Katji na Katji is situated within the study area about 40 km south west of the proposed drill sites.

Integration of the above presented information and evidence postulates a general hydrogeological concept with high transport capacity basal Kalahari unit consisting of conglomerate and gravels, this conceptual position is informed by several investigators (Boocock & Van Straten, 1962; Thomas & Shaw, 1991; Jones, 2010). Boocock & Van Straten (1962) contend that the basal gravels and conglomerate are extensive in the Kalahari Group and reflect the importance of the post Gondwanaland endorheic drainage system, whereas Thomas & Shaw (1991) state that marls are reportedly been found above the basal gravel but are confined to northern Namibia.

The second aquifer unit of the Kalahari in the study area is the medium sand and sandstone layer of the middle Kalahari, this aquifer although reported be consistent by Kuells (2000) is expected to be discontinuous in this conceptual model given evidence of drying conditions which followed the basal Kalahari in which the hydrological regime is reported to have been ephemeral with wide spread deposition of laterite and duricrust (alternate hot and wet conditions) and discontinuous clay horizons. Drilling at both Goblenz and Katji na Katji confirm the presence of this red to pink sandstone at the depth of around 150 m depending on where you are in the basin.

This study does recognise the presence of the largely Aeolian upper Kalahari but does not appreciate it as an aquifer. This position is informed by the low energy drainage nature of the upper Kalahari presented in fine and silty sediment. However, where local streams have been uplifted by igneous impalements i.e. the first 68 km of the Omatako River within the survey area up to the village of Ncaute the energy and mass transport capacity of the upper Kalahari can be considered as a local aquifer, particularly around stream banks where the stream channel has been burying and shifting away from. In this zone of the upper Kalahari water levels can be as shallow as 10 m and borehole depths of 70 m can yield up to 30 m³/h with very high variability, therefore this is not a well-developed aquifer system.

Based on the above give hydrogeological concept, the deep and regional groundwater flow system (Fig. 4.5) equivalent to the lower Kalahari aquifer unit benefits from direct recharge around the rim of the basin and from elevated outcrops, would characteristically artesian (marl & clay confining layer) with elevated total dissolved solids (TDS) due a long resident times, and therefore prone to poor water quality. This system is not expected to be shallower than 160 m except where elevated by igneous intrusions.

The middle Kalahari aquifer (Fig. 4.5), which is largely fine/medium grained sand and sandstone as stated earlier would benefit from leakage recharge from the upper Kalahari and is therefore expected to be semi-confined to confined in places, with limited storage capacity outside current or/and outside palaeo-stream channels. Water quality will be acceptable for human consumption along stream channels but may deteriorate away from existing or from palaeo-stream channels.

On the basis of the developed conceptual hydrogeology model (Fig. 4.5 and Table 4.1) of the study area, the Karoo sandstone/conglomerate and lower Kalahari aquifers are expected to be confined and therefore prone high hydraulic pressures during drilling, this applies to any significant water bearing layer in the Damara Aquifers, particularly fractured quartzite and dolomite/limestone formations. The depth of these aquifer units cannot be estimated but the onset of the Karoo is marked by gravity sediments – the Dwyka Formation which is a conglomerate or tillite, whereas the onset of the Kalahari is also marked by fluvial gravels and conglomerates. These two stratigraphic markers should

produce more water than others; that is besides fractured quartzite and dolomite/limestone of the Damara Sequence.

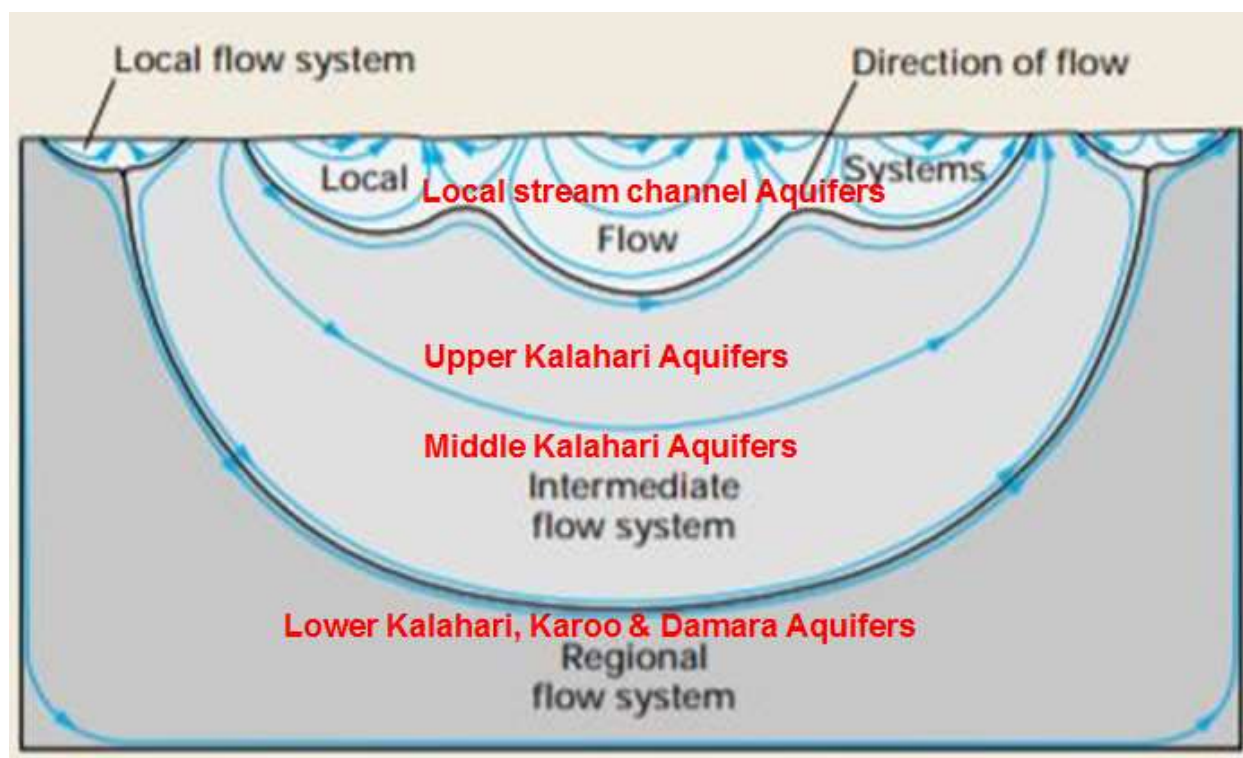


Figure 4.5: Conceptual groundwater flow components around PEL 73.

Table 4.1: Conceptual hydrogeology characteristics of the study area.

GROUP / SEQUENCE	STRATIGRAPHIC UNIT	DESCRIPTION	
		Nature Type	Aquifer Potential
Kalahari	Fine and Silt	Aquitard, leaky	Low Yielding, locally high Yielding
	Sandstone, Sand & Clay	Aquifer	Low Yielding
	Marl and Clay	Confining Layer	None
	Conglomerate & Gravel	Aquifer	High Yielding
Karoo	Basalt/Sandstone	Aquitard/Weathered	Conditional
Damara	Schist/Quartzite/dolomite	Aquitard/Fractured	Conditional

4.5.2.3 Water and Environment

A generic water environment consists many measurable components and among others the important ones are rates of water flow, water flow direction, water stagnating/ponding, water flow pathways, replenishment of water sources, changes in storage, discharging of water from water bodies, physio-chemical, existing/expected organic load of the area and biological character of the water, flooding and depletion of water resources, water resources contamination as well as the terrestrial and aquatic life supported by water bodies.

The proposed 2D seismic survey operations will be undertaken on surface along existing roads and tracks with little to no implication and the vulnerability to subsurface groundwater resources.

4.6 Archaeology

4.6.1 Overview of Archaeological Resources in PEL 73

Previous systematic archaeological investigations of the Kavango East and West Regions revealed human occupations that predate the pre-colonial farming settlements. In addition to archaeological heritage, modern heritage of Kavango East and West Regions is characterised by remnants of numerous historic, sacred cultural sites as well as present-day community graves and cemeteries mainly along the Omatako River basin not affected by the proposed 2D seismic survey operations.

4.7.2 Archaeological Baseline Findings

The desk archaeological heritage impact assessment study has only identified a group of archaeological heritage sites within the footprint of the proposed project. These are located along the Omatako River basin between Ncaute and Taratara villages (Table 4.2 and Fig. 4.6). Additionally, a group of other sites whose quantity has not been established are also found south west of Omatako River basin.

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

If they do occur, the nature of anticipated archaeological materials along the Omatako river course will likely be of diagnostic nature from Late Stone Age period due to the spread of the industry in this area. However, such surface artefacts will have no archaeological values because they will likely be been already disturbed by extensive agricultural activities all along the Omatako river course (Plate 4.1).

Table 4.2: GPS coordinates of the identified archaeological sites reflected in Fig. 4.6.

Site No.	GPS location	Region	Constituency
1	18°13'54.72"S / 19°44'9.88"E	Kavango East	Mcuma/Chimpanda
2	18°21'50.17"S / 19°49'53.12"E	Kavango East	Shikambu
3	18°21'48.47"S / 19°51'24.65"E	Kavango East	Baramasono
4	18°11'1.21"S / 20°10'15.72"E	Kavango East	Baramasono
5	18°10'59.89"S / 20°11'18.68"E	Kavango East	Taratara

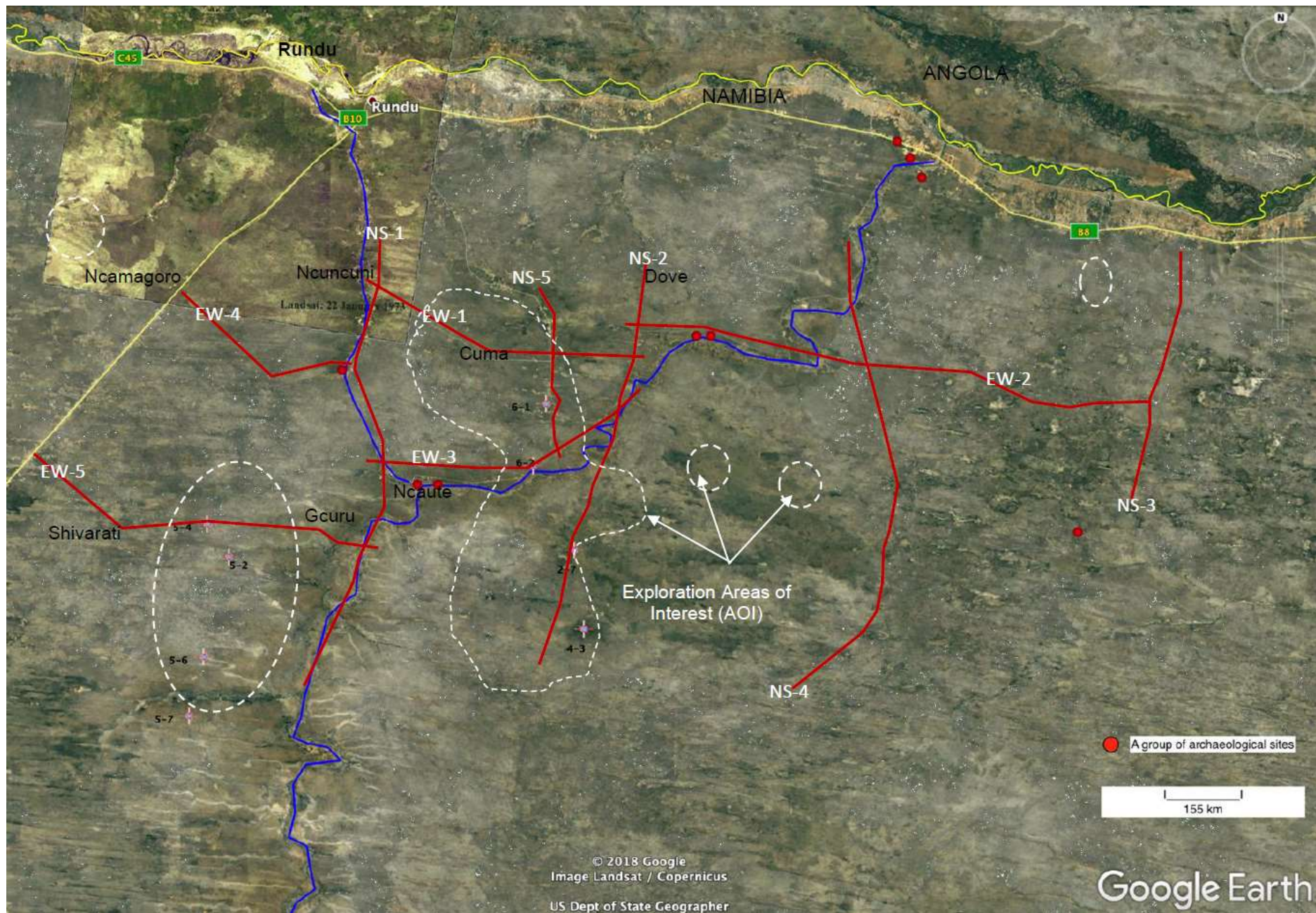


Figure 4.6: A group of archaeological sites (red dots, quantities not established) in relation to the proposed 2D seismic survey lines (red lines) to be conducted along existing roads and tracks. The blue lines indicate the Omatako Ephemeral River channels.



Fully Ploughed Omatako Ephemeral River Channel

Plate 4.1: Extensive human induced disturbances including agricultural activities all along the Omatako river course that could have resulted in the disturbances of any archaeological resources in the area.

4.7 Stakeholder Consultations and Engagement

4.7.1 Overview

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

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

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

4.7.2 Stakeholders Consultation Process to be Undertaken

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

Public and stakeholder consultations process covering all the Interested and affected Parties (I&APs) will be conducted during the month of January 2021 (Fig. 4.7). Copies of the Environmental Reports to be prepared will be distributed to all key institutional stakeholders including the line Ministries, Offices of the Governors of Kavango West and Kavango East Regions and traditional authorities. Furthermore, copies of the reports will also made available at Public Libraries in Windhoek, Kavango West and Kavango East Regions. Public notices will be published in the local newspapers inviting all I&APs to registered as stakeholders. Additional local consultation outreach process will be undertaken through the Offices of Governors for Kavango West and Kavango East Regions.

All registered stakeholders and the public will be notified on the dates and times for meetings and open days sessions to be organised in Kavango East and West Regions. The following public meetings and open days sessions will be organised during the month of January 2021 as part of the stakeholder and public consultation process for the proposed 2D seismic survey operations in PEL 73:

- (i) Public and institutional stakeholders meetings and open days sessions in Rundu and Nkurenkuru.
- (ii) Public open days sessions in Rundu and Nkurenkuru, and.
- (iii) Field-based public / local community meetings and poster sessions at key settlements such as Ncamagoro, Gcuru, Ncuncuni, Cuma, Mbambi, Ncaute and Kawe, all situated long the various seismic survey lines. The field-based meetings will be undertaken in consultations with the regional councils and traditional authorities covering all the key stakeholders groups in Kavango East and West regions.

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

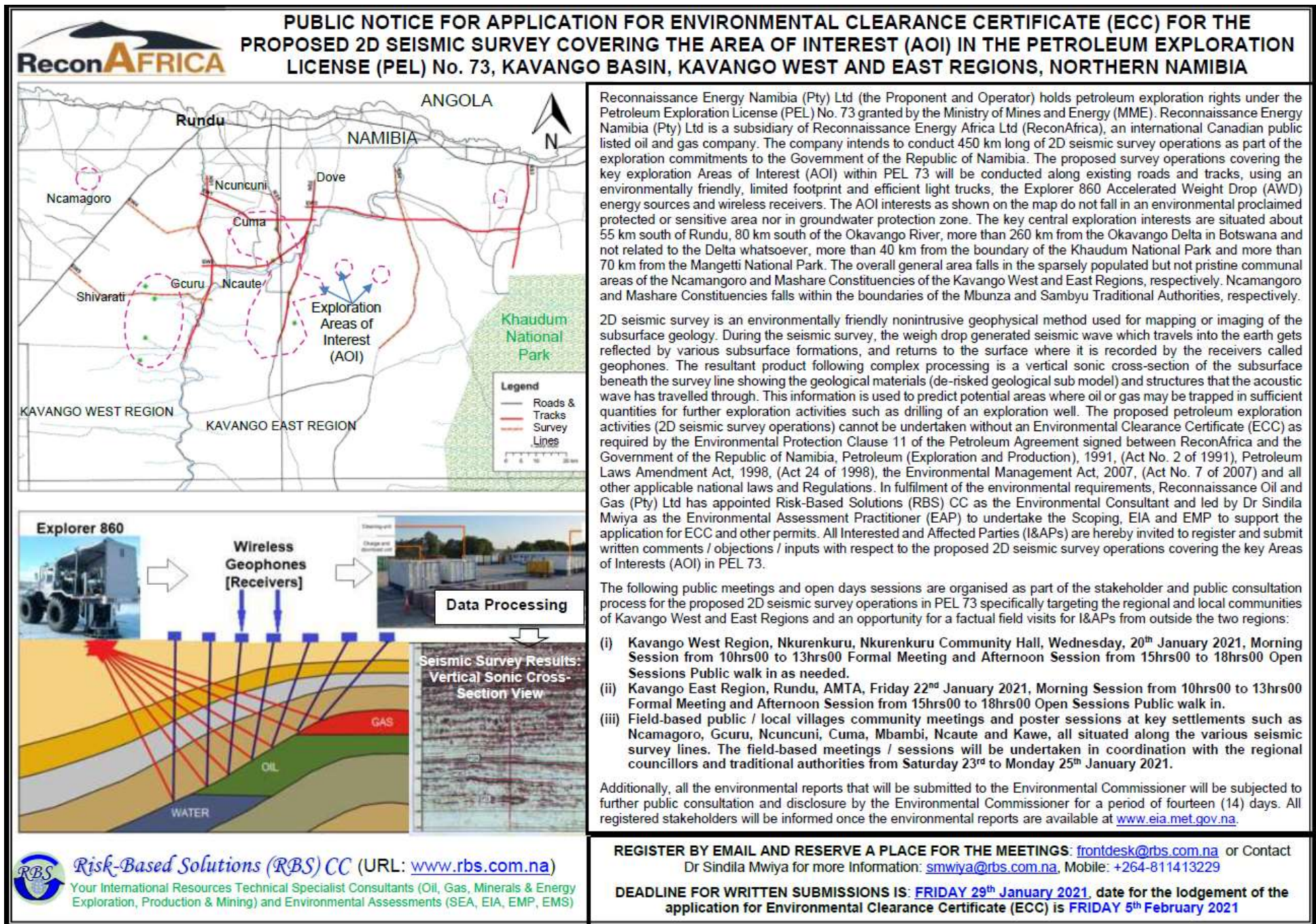


Figure 4.7: Updated copy of the public notice first published in the New Ear dated 7th January 2021 and to be published in various other newspapers throughout the month of January 2021.

5. EIA AND EMP TERMS OF REFERENCE (ToR)

5.1 Terms of Reference (ToR) Overview

The environmental assessment process adopted for this project took into considerations the provisions Environmental Protection Clause 11 of the Petroleum Agreement signed between ReconAfrica and the Government of the Republic of Namibia, Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991), Petroleum Laws Amendment Act, 1998, (Act 24 of 1998), the Environmental Management Act, 2007, (Act No. 7 of 2007) and all other applicable national laws and Regulations.

Summary of the proposed activities, alternatives and key issues considered during the Environmental Assessment (EA) process are summarised in Table 5.1. The EIA and EMP process for the proposed 2D seismic survey operations shall be performed with reasonable skill, care and diligence in accordance with professional standards and practices existing at the date of performance of the assessment and that the guidelines, methods and techniques used and applied in this study conformed to the national regulatory requirements, process and specifications in Namibia and in particular as required by Ministry of Mines and Energy (MME), Ministry of Environment, Forestry, and Tourism (MEFT) and the client (Proponent). The preparation of the EIA and EMP reports was undertaken in line with the January 2015 MEFT Environmental Assessment Reporting Guideline.

5.2 Summary of EIA Approach and Methodology

5.2.1 Overview of the EIA Methodology

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

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

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

Prior to the field study, a desktop studies were conducted to review the available reports, and to design plans and maps to compile relevant biophysical and socioeconomic information of the project area. Biophysical studies covered environmental aspects such as physiography, climate, hydrology, drainage, soils, geology/hydrogeology, vegetation, wildlife, and aquatic environment. The socio-economic environmental study covered information on issues such as population, literacy, social amenities (healthcare and schools), land use, land tenure, the social dimensions of wellbeing and income levels, water supply, sanitation levels and security, along with other pertinent issues. The field-based study also used to validate the data compiled during the desktop study.

Table 5.1: Summary of the proposed activities, alternatives and key issues considered during the Environmental Assessment (EA) process covering EIA.

PROPOSED 2D SEISMIC SURVEY PROJECT ACTIVITIES	ALTERNATIVES CONSIDERED	KEY ISSUES TO BE EVALUATED AND ASSESSED WITH ENVIRONMENTAL MANAGEMENT PLAN (EMP) / MITIGATION MEASURES PREPARED	
(i) Planning and mobilisation (Pre-survey preparation). (ii) Camp sites setups and widening of tracks and creation of limited new access as may be applicable. (iii) Actual data acquisition, and. (iv) Demobilisation and Closure (Survey Completion).	(i) Survey location with respect to the PEL and Area of Interest (AOI)	Potential land use conflicts / opportunities for coexistence between proposed exploration and other existing land uses such as agriculture, community forestry, timber harvesting conservation and tourism	
	(ii) Profiles / survey lines kms length and location	Physical Environment	1. Water quality 2. Physical infrastructure and resources 3. Air quality, noise, and dust 4. Landscape and topography 5. Soil quality 6. Climate change influences.
	(iii) Energy source (Vibroseis, Explorer 860 or Dynamite)	Biological Environment	1. Habitat 2. Protected areas and resources 3. Flora 4. Fauna 5. Ecosystem functions, services, use values and non-use or passive use.
	(iv) Receivers / Geophones (Wireless or Cabled)	Socioeconomic, cultural, and archaeological environment	1. Local, regional, and national socioeconomic settings 2. Subsistence agriculture 3. Community forestry 4. Tourism and recreation 5. Cultural, biological, and archaeological resources
	(v) Other alternative land, roads and tracks uses	Environmental Management Plan (EMP) Providing Mitigation Measures and Monitoring Plan	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.
	(vi) Ecosystem Function (What the Ecosystem Does)		
	(vii) Ecosystem Services		
	(viii) Use Values		
	(ix) Non-Use, or Passive Use		
	(x) The No-Action Alternative		

5.2.2 Summary of the Environmental Assessment Process and Steps

The EIA and EMP process used for this project took into considerations the provisions of the Environmental Impact Assessment (EIA) Regulations, 2012 and the Environmental Management Act (EMA), 2007, (Act No. 7 of 2007) as outlined in Fig. 5.1. The environmental assessment steps undertaken or still to be taken are summarised as follows (Fig. 5.1):

- (i) Project screening process (**Undertaken in November 2020**).
- (ii) Preparation of the Draft Scoping Report with Terms of Reference (ToR) for review by the Proponent (**Undertaken in November and December 2020**).

- (iii) Preparation of the Public Notice to be published in the local newspapers as part of required public consultation process (**Undertaken in December 2020**).
- (iv) Opened the Stakeholder register (**Undertaken on the 7th January 2021**).
- (v) Invitation / notices to stakeholders and the general public to participate in environmental assessment process issued through the local newspaper advertisements as well as via direct emails communications to key stakeholders institutions such as Line Ministries, Regional and Local Governments as may be applicable (**Undertaken in January 2021 for a period of 21 days from the 1st Public Notice Publication dated 7th January Published in the New Era Newspaper** (Fig. 5.2).
- (vi) Project registration / notification through the completion of the online formal registration / notification form on the MEFT online Portal (www.eia.met.gov.na), together with the hardcopies of the Draft BID/Scoping Report with ToR submitted to the Environmental Commissioner in the MEFT through the Ministry of Mines and Energy (MME) Director of Energy (Competent Authority) for review (**Undertaken on the 12th January 2021**).
- (vii) Preparation of the Draft EIA and EMP Reports for client review, public and stakeholder inputs (**To be Undertaken in January 2021**).
- (viii) Comments and inputs from the client and stakeholder consultations used to finalise the EIA and EMP Reports (**To be Undertaken in January and February 2021**).
- (ix) The final EIA and EMP reports to be 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 (**February 2021**).
- (x) Following the submission of the application for ECC to the Environmental Commissioner, the public and stakeholders who are interested or affected by the proposed project will have additional **fourteen (14) days** to submit comments / inputs about the proposed 2D seismic survey operations direct to the Environmental Commissioner when the application will be 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 or Decisions (RDs) from the Environmental Commissioner (**From February 2020**).

5.2.3 Assumptions and Limitations

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

- ❖ The proposed 2D seismic Survey activities as well as all the plans, maps, PEL, Area of Interest, profiles / survey line boundary / coordinates, and appropriate data sets received from the Proponent, project partners, regulators, Competent Authorities, and specialist consultants are assumed to be current and valid at the time of conducting the studies and preparation of this EIA Report.
- ❖ The impact assessment outcomes, mitigation measures and recommendations provided in the EIA and EMP Reports are valid for the lifecycle or repeat of the proposed 2D seismic survey operations.
- ❖ A precautionary approach has been adopted in instances where baseline information and impact assessment guidelines were insufficient or unavailable or site-specific project activities were not yet available, and.

- ❖ Mandatory timeframes as provided for in the EIA Regulations No. 30 of 2012 and the EMA, 2007, (Act No. 7 of 2007) have been observed.

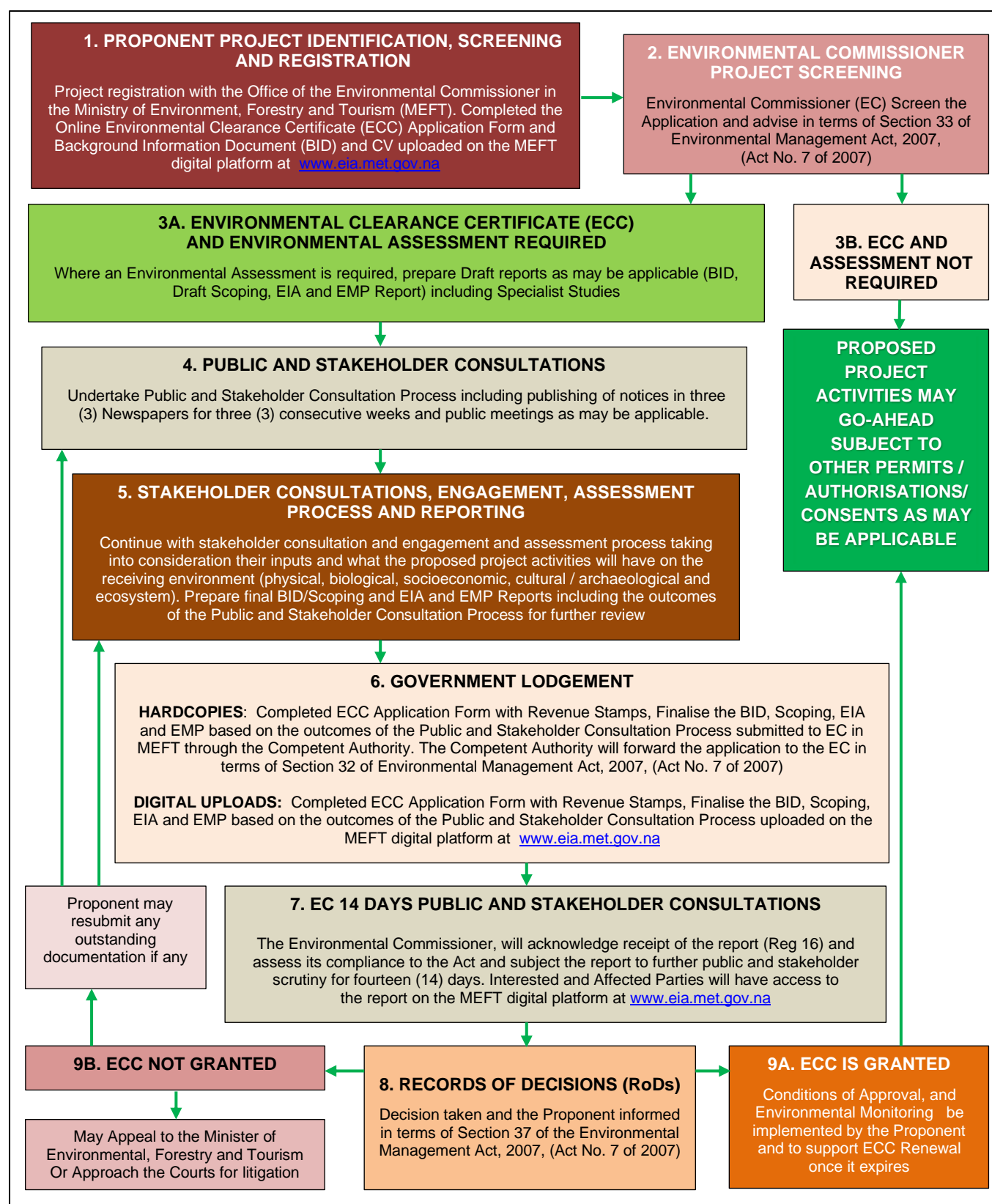


Figure 5.1: RBS Schematic presentation of Namibia's Environmental Assessment Procedure.

'Don't leave me this way'

... sing Britons in Spain as Brexit kicks in

JIMERA DE LIBAR – Bangers and mash, pints of beer, a Europeans vs Britons tug-of-war and renditions of "Don't Leave Me This Way" and "We'll Meet Again". UK expats in Spain marked Britain's departure from the European Union in true British style.

Although many are unhappy at the decision to leave, with some facing residency and other bureaucratic problems, Britons at the Bar Alioli in the southern village of Jimera de Libar decided to make the best of a bad job and throw a party.

The tongue-in-cheek celebration featured a menu of all British favourites such as fish and chips and beans on toast.

"While most of us are not altogether happy about the whole thing, we might as well celebrate in a fashion and enjoy ourselves," said Paul Darwent, a 65-year-old Briton who runs the bar in the Andalusian mountains about an hour by car from the coast.

"The reality is it is going to create a lot of problems for us all," added Darwent, who has lived in Spain for over two decades, in a reference to



Blowing out... A man holds the Union Jack at Anti-Brexit British bar during throws mock EU goodbye party in Jimera de Libar. Photo: Nampu/AFP

Britain's completion of its divorce from the European Union (EU) on 31 December.

Around 370 000 Britons are registered as living in Spain – more than in any other EU country – and thousands more are believed to be settled in the country without ever having notified the authorities.

Many are retirees who live on Spain's sunny southern coast, drawn by the country's warmer climate and lower cost of living.

Britons can keep their residency rights in Spain – as long as they applied for residency before 31 December, when Britain's transition period out of the EU ended.

To qualify, they must have a permanent address, a local bank account, show sufficient funds and have healthcare cover.

Many, however, do not meet the requirements, said Myra Azzopardi, a paralegal and the founder of the Citizens Advice Bureau (CAB), a British charity that helps expats with legal issues.

"We are going to have a lot of people who are going to end up without residency and without any way of getting residency," she told AFP.

Baz Rhodes, a 58-year-old paragliding guide from Manchester who has lived in Spain for 20 years,

said Brexit meant he and his wife had to take out private health insurance at a cost of 200 euros (\$245 euros) a month.

"I am very, very annoyed," said Rhodes, who attended the party wrapped in a EU flag.

Because of pandemic restrictions, the party was held on the bar's outdoor patio, which was decorated with British, Spanish and EU flags.

Separate entrances for EU and non-EU nationals were set up to enter the bar to use washrooms.

The musical backdrop to the festivities included live performances of The Communards'

"Don't leave me this way" and Vera Lynn's "We'll meet again".

The highlight of the party was a match of tug-of-war pitting four British men against four men from Denmark, France, the Netherlands and Spain.

Cheers and applause broke out when the EU team won, causing the British team to tumble to the ground.

"If we don't celebrate in some way, we would just be crying because it is so sad," Elaine Gillilan, a teacher from Scotland who has lived in Spain for nearly two decades, commented.

She said she was saddened that it is now much harder for her children to move to Spain, like she did, or any other EU nation.

From Friday onwards, any Briton who wants to live in Spain must follow the same procedure as for all non-EU citizens, which is more complex and difficult, with higher income requirements.

And their professional qualifications will no longer be automatically recognised in Spain. They will have to apply for it, with no guarantee of success.

"We should be together. We are one continent. I think Britain will suffer as a result. It is not good for any of us," added Gillilan.

- Nampu/AFP

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. 73, KAVANGO BASIN, KAVANGO WEST AND EAST REGIONS, NORTHERN NAMIBIA

Reconnaissance Energy Namibia (Pty) Ltd (the Proponent and Operator) holds petroleum exploration rights under the Petroleum Exploration License (PEL) No. 73 granted by the Ministry of Mines and Energy (MME). Reconnaissance Energy Namibia (Pty) Ltd is a subsidiary of Reconnaissance Energy Africa Ltd (ReconAfrica), an international Canadian public listed oil and gas company. The company intends to conduct 450 km long of 2D seismic survey operations as part of the exploration commitments to the Government of the Republic of Namibia. The proposed survey operations will be conducted along existing roads and tracks, using an environmentally friendly, limited footprint and efficient light trucks, the Explorer 880 Accelerated Weight Drop (AWD) energy sources and wireless receivers.

2D seismic survey is an environmentally friendly noninvasive geophysical method used for mapping or imaging of the subsurface geology. During the seismic survey, the generated seismic wave which travels into the earth gets reflected by various subsurface formations, and returns to the surface where it is recorded by the receivers called geophones which are like microphones. The resultant product following complex processing is a vertical sonic cross-section of the subsurface beneath the survey line showing the geological materials (de-risked geological sub model) and structures that the acoustic wave has travelled through. This information is used to predict potential areas where oil or gas may be trapped in sufficient quantities for further exploration activities such as drilling of an exploration well.

The proposed 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 ReconAfrica and the Government of the Republic of Namibia, Petroleum (Exploration and Production), 1991, (Act No. 2 of 1991), Petroleum Laws Amendment Act, 1998, (Act 24 of 1998), the Environmental Management Act, 2007, (Act No. 7 of 2007) and all other applicable national laws and Regulations. In fulfillment of the environmental requirements, Reconnaissance Oil and Gas (Pty) Ltd has appointed Risk-Based Solutions (RBS) CC as the Environmental Consultant and led by Dr Sindia Mwiya as the Environmental Assessment Practitioner (EAP) to undertake the Scoping, EIA and EMP to support the application for ECC and other related 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 73.

All registered stakeholders and the public will be notified on the dates and times for meetings and open days sessions to be organised in Kavango East and West Regions. The following public meetings and open days sessions will be organised during the month of January 2021 as part of the stakeholder and public consultation process for the proposed 2D seismic survey operations in PEL 73:

- (i) Public and institutional stakeholders meeting in Rundu and Nkurenkuru.
- (ii) Public and institutional stakeholders open day sessions in Rundu and Nkurenkuru.
- (iii) Field-based public / local community meetings and poster sessions at key settlements such as Nkurenkuru, Cuma, Mbambi, Ncaule and Kaire, all situated along the various seismic survey lines. The field-based meetings will be undertaken in consultations with the regional councils and traditional authorities covering all the key stakeholder groups in Kavango East and West regions.

REGISTER BY EMAIL: scoping@rbs.com.na or Contact Dr Sindia Mwiya for more information: smwiya@rbs.com.na, Mobile: +264-8114133229

DEADLINE FOR WRITTEN SUBMISSIONS IS: **FRIDAY 29th January 2021**, date for the lodgement of the application for Environmental Clearance Certificate (ECC) is **FRIDAY 5th February 2021**

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

Your International Resources Technical Specialist Consultants (Oil, Gas, Minerals & Energy Exploration, Production & Mining) and Environmental Assessments (SEA, EIA, EMP, EMU)

Figure 5.2: Copy of the Public Notice published in the New Era Newspaper dated Thursday, 7th January 2021 marking the 1st day of the more than 21 days for public consultations for the proposed 2D seismic survey operations.

5.3 EIA and EMP Objectives, Assumptions, Alternatives and Receptors

5.3.1 Objectives of the EIA and EMP Phases

The aims and objectives of the Environmental Assessment (EA) covering the EIA and EMP to be prepared for the proposed 2D seismic survey operations over the areas of interest in PEL 73 are:

- (i) To assess all the likely positive and negative short- and long-term impacts on the receiving environment (physical, biological and socioeconomic environments) at local survey lines areas, regional (Kavango West and East Regions), national (Namibia) and Global levels using appropriate assessment guidelines, methods and techniques covering the complete project lifecycle.
- (ii) To develop appropriate mitigation measures that will enhance the positive impacts and reduce the likely negative influences of the negative impacts identified or anticipated. Such mitigation measures shall be contained in a detailed EMP report covering the entire project lifecycle, and.
- (iii) To undertake the environmental assessment process and prepare EIA and EMP Reports with reasonable skill, care and diligence in accordance with professional standards and practices existing at the date of performance of the assessment and that the guidelines, methods and techniques that have been applied are all in conformity to the national regulatory requirements, process and specifications in Namibia as required by Ministry of Mines and Energy (MME), Ministry of Environment, Forestry and Tourism (MEFT), and.
- (iv) Prepare the EIA and EMP Reports in line with the January 2015 MEFT Environmental Assessment Reporting Guidelines.

5.3.2 Proposed Project Alternatives and Ecosystem Assessments

The following alternatives have been considered as part of the Environmental Scoping study and shall be reviewed and fully assessed during the EIA and EMP process with respect to the proposed 2D seismic survey operations:

- (i) **Survey location with respect to the PEL and Areas of Interest (AOI):** The targeted areas of interest are site-specific and related to the regional and local geology and petroleum system of a specific area to which there are no alternative sites to consider with respect to the license area. The only other alternative is the no-action option (no project activities are implemented).
- (ii) **Profiles / survey lines kms length, roads, and tracks to be used:** The proposed 2D seismic survey operations will be undertaken along north-south and east west oriented existing roads and tracks. Several alternative roads and tracks have been identified and exist in the area. Alternatives to the proposed survey line lengths are also possible along the existing selected and alternative roads and tracks and will be reviewed in the EIA Report.
- (iii) **Energy source (Vibroseis, Explorer 860 or Dynamite):** Section 2.3.2 provides a detailed comparative assessment on the use of vibroseis, dynamite or Explorer 860 for the proposed 2D seismic operations in PEL 73. The Explorer 860 has been selected because it provides impressive peak force, excellent frequency content with high productivity and minimal environmental impact with a single unit per source point (3 units on project), 860,000 lbs. of adjustable force, faster than vibroseis, zero phase data same as dynamite, closest operating limits to infrastructure and perfect for high density population and environmentally sensitive areas, patented source technology, very fast 10 seconds between pops and typically 3-4 pops per Source Point (SP) and very high fold capability.
- (iv) **Receivers / Geophones (Wireless or Cabled):** Latest wireless geophones / receivers / recorders will be used in the proposed 2D seismic survey instead of cabled old technology systems. The proposed survey will use the STRYDE recording technology which represents the latest, smallest, and most easily deployable system on the market with a wider line offsets that does not require extensive vegetation clearing, scales to thousands of channels, flexibility

to deploy over demanding terrains, higher productivity with no downtime for cable repairs, reduced crew and transportation costs, small footprint, improved safety and reduced risk of injury.

- (v) **The No-Action Alternative** - A comparative assessment of the environmental impacts of the 'no-action' alternative (a future in which the proposed 2D seismic survey activities do not take place) has been undertaken. An assessment of the environmental impacts of a future, in which the proposed exploration and possible discovery of economic petroleum resources does not take place, may be good for the receiving environment because there be no any form of negative environmental impacts due to proposed exploration or possible petroleum production operations will take place in the area. The environmental benefits will include no negative environmental impacts on the receiving environment. However, it is important to understand that even if the proposed exploration activities do not take, to which the likely negative environmental impacts are likely to be low and localised, the current and other future land uses will still have some negative impacts on the receiving environment.

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

- (vi) **Land Uses and Conflicts:** The proposed survey area falls within the sparsely populated communal land of the Kavango West and East Regions. Communal subsistence agricultural land uses area dominated by stock and seasonal crop farming practices. Several community forests exist in the area with existing roads and tracks cutting across these areas. Due to the limited scope of the proposed 2D seismic survey operations centred around the existing roads and tracks, it is likely that the proposed activities will coexist with the current land and future uses in the area.
- (vii) **Ecosystem Function (What the Ecosystem Does):** Ecosystem functions such as wildlife habitats, carbon cycling or the trapping of nutrients and characterised by the physical, chemical, and biological processes or attributes that contribute to the self-maintenance of an ecosystem in this area are vital components of the receiving environment. However, subject to the outcomes of the EIA, the proposed 2D seismic survey activities may not affect the ecosystem function due to the limited scope centred around the existing roads and tracks.
- (viii) **Ecosystem Services:** Food chain, harvesting of animals or plants, and the provision of clean water or scenic views are some of the local ecosystem services associated with the proposed project area. However, subject to the outcomes of the EIA, the proposed 2D seismic survey activities may not affect the ecosystem function due to the limited scope centred around the existing roads and tracks.
- (ix) **Use Values:** The proposed project area has direct values for other land uses such as agriculture, conservation, and tourism as well as indirect values which includes: Watching a television show about the general area and its wildlife, food chain linkages that sustains the complex life within this area and bequest value for future generations to enjoy. Subject to the outcomes of the EIA, the proposed 2D seismic survey activities will not destroy the current use values because the activities will be centred around the existing roads and tracks, and.

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

5.4 Summary of the Likely Positive and Negative Impacts

5.4.1 Summary of Likely Positive Impacts

The proposed 2D seismic survey operations covering the areas of interest in PEL No. 73 will have greater positive impacts in terms of monetary contributions to the central government (Ministry of Mines and Energy) revenue pool as well as contribute great to the knowledge and understanding of the petroleum systems of the newly discovered Kavango Basin. The following is the summary of the key positive impacts:

- ❖ Increased earnings to the State Revenue through rental fees as well as contributions to the training fund held by National Petroleum Corporation of Namibia, NAMCOR.
- ❖ Increased temporal contracts and employment opportunities for local services providers and local revenue circulation from ancillary (industrial support) service demands.
- ❖ Improved rural infrastructure services such clearing of poorly accessible tracks.
- ❖ Demand for some public services may increase.
- ❖ Unemployment may decrease.
- ❖ Utility payment increase and infrastructure may be expanded, and.
- ❖ Improved knowledge on other potential subsurface natural resources that may be associated with the area such water, minerals, and geothermal resources.

Overall, the proposed development will significantly and temporarily contribute to the rural local economic activities and a catalyst for local growth through capital injection and various taxes that will be payable.

5.4.2 Summary of Receptors Likely to be Negative Impacted

5.4.2.1 Vibration, Noise and Dust (Air Quality)

The following are possible sources of vibrations, air and dust pollution that shall be evaluated and assessed further during the EIA and EMP process:

- (i) Vibrations and noise:
- ❖ Survey equipment: There will be noise generated from survey equipment and light vehicles.
 - ❖ Project infrastructure: Due to the unpaved road even though in good condition, vehicular activity will increase which may influence the local environment, and.
 - ❖ Fly campsite: Construction of the fly camp facilities may increase ambient noise.
- (ii) Air quality:

- ❖ Survey equipment: Survey equipment and light vehicle will all generate small volumes of dust especially during the dry season.
- ❖ Project infrastructure: Air quality (dust) will deteriorate because of increased volume of vehicular activities during survey operation from the roads (unpaved) and tracks though in good conditions, and.
- ❖ Burning of fuels fumes will contribute to the localised small percentage to air quality deterioration.

5.4.2.2 Fauna and Flora Receptors

The proposed 2D ground seismic survey lines /profiles have been positioned along existing roads and tracks or already cleared areas / fields. Only minimum widening of existing tracks may be necessary in some places in order for the survey vehicles to pass easily. The fly camp site will be situated on an area which is already cleared including the use of the already existing facilities in Rundu and current drilling locations. No vegetation will be removed for the temporary campsite and no big trees will be removed along existing tracks.

The proposed survey area and areas of interest are not part of the habitats known to be associated with the free roaming northern and north-eastern Namibian herds of elephants that migrates between Kaudum and Mangetti National Parks as claimed by those who do not know the areas of interest, the local habitat areas and never been in the field to familiarised themselves with the field-based conditions. Elephant are known to use infrasound communication with frequencies from 14-35 Hz for long distance communication with the best period for such communication just after sunset when night-time cooling enhances low-frequency sounds and thus maximises communication ranges (Garstang et al. 1995). Furthermore, elephant also use seismic communication – i.e. ground borne stimuli which works better in sandy soils – to avoid or threaten predators, assess and navigate within the environment, and communicate (O’Connell-Rodwell 2007, O’Connell-Rodwell et al. 2007).

However, elephants are not sedentary in the proposed development area and mainly located to the east, in the Kaudum National Park with occasional movements to the west and south, between Kaudum and Mangetti National Parks and north-east between the Kaudum National Park and Mahangu Core Area. The seismic surveys will be executed to the north and west of most elephant activities as well as be conducted only during daylight hours along existing roads and tracks. The proposed survey operations covering the key exploration Areas of Interest (AOI) within PEL 73 will be conducted using the Explorer 860 Accelerated Weight Drop (AWD) energy sources and wireless receivers for better line offsets. The “weight-drop” which generates a thump as it hits the ground is not expected to have any frequency specific interference with the natural receiving environment.

2D seismic survey operations using heavy Vibroseis trucks were successfully undertaken in Kavango West in 2018 without any impact on the local fauna or flora.

Despite the fact that the proposed 2D seismic survey operations will be undertaken along existing roads and tracks, it is hereby recommended that a field-based fauna and flora specialist assessment be undertaken as part of the EIA and EMP to have a broader understanding of the local fauna and flora diversity of the local area.

5.4.2.3 Protection of Water Resources

The primary risk of contamination of soils, surface waters and aquifers, is from the fuel leakages as well as emissions from the fly camp sites. Although the risk of such contamination is highly localised, it has the potential to impact the local areas. Therefore, the 2D seismic survey operations should remain under strict surveillance along the survey lines and at the camp site. However, the proposed 2D seismic survey lines will be undertaken along existing roads and tracks and the camp sites locations will be situated in already disturbed areas and will also use existing facilities as far as possible all to be situated far away from ephemeral river channels or groundwater recharge zones. Overall, the proposed survey area does not fall within the ground water protected area or highly vulnerable groundwater pollutions zones as shown in Fig. 5.3.

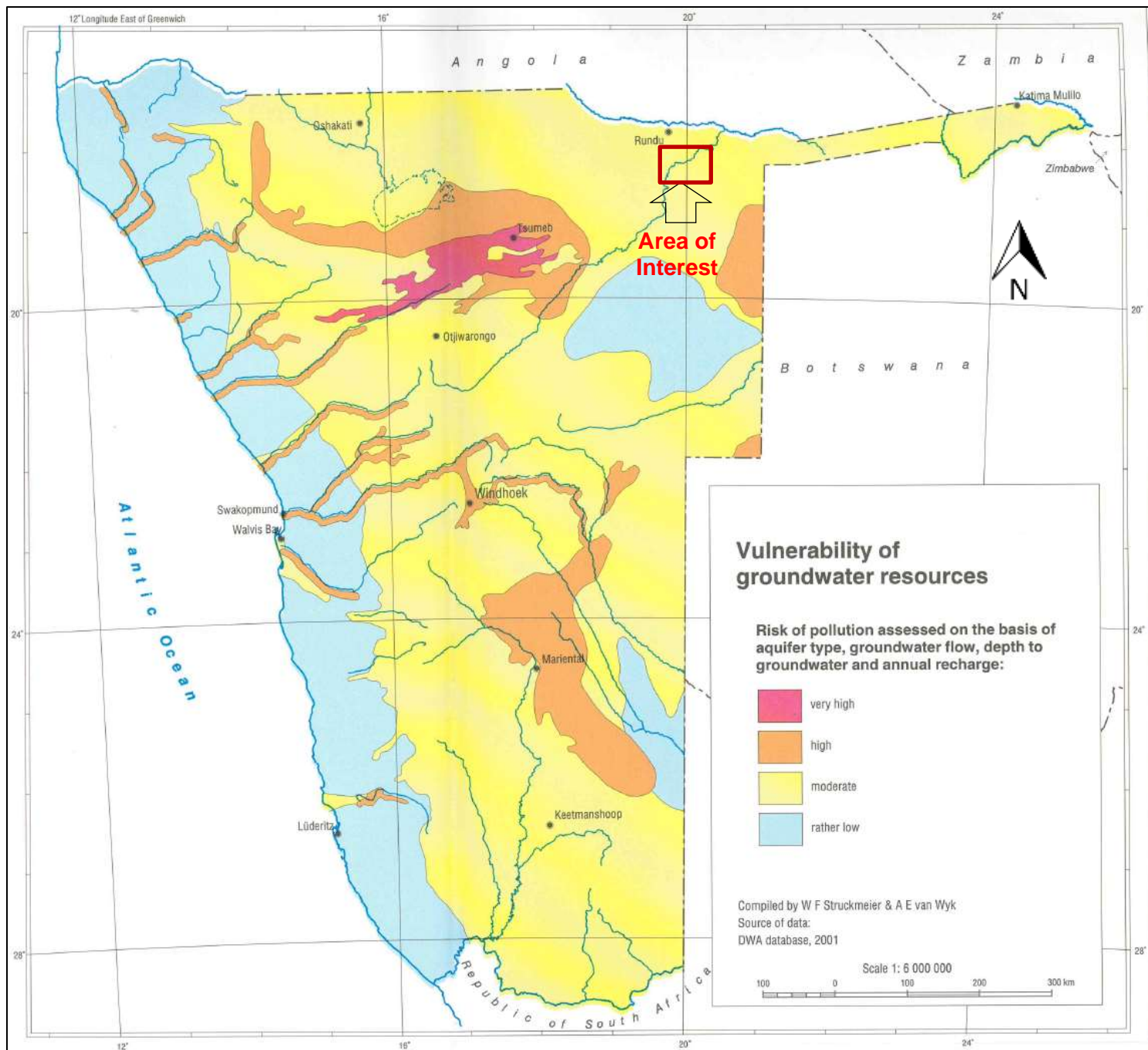


Figure 5.3: Regional groundwater vulnerability around the PEL 73 (Source: Department of Water Affairs and Forestry, 2001).

5.4.2.4 Archaeology

In addition to archaeological heritage, modern heritage of Kavango West and East Regions is characterized by remnants of numerous historic, sacred cultural sites as well as present-day community graves and cemeteries that are to be avoided. Earliest archaeological heritage is attributed to the Late Iron Age settlements, restricted along the Okavango River basin. This industry is evidenced by numerous archaeological artefacts including but not limited to ceramics (decorated & undecorated), small number of imported glass trade beads, some stone artefacts, worked ostrich eggshells and iron implements.

However, the proposed 2D seismic survey lines to be undertaken along the existing roads and tracks will not likely affect local archaeological resources although existing disturbance of the areas through previous land-use system and existing infrastructure development activities would or might have probably already compromised some of the sites if existed.

Due to their established significance, the identified archaeological sites within the survey area must still be treated as “no go zones” and no disturbances should occur given their vulnerability nature and sensitivities. It is hereby recommended that an assessment review of the identified archaeological sites by a specialist be considered as part of EIA with respect to the proposed 2D seismic survey operations.

5.4.2.5 Socioeconomic Components

Socioeconomic impacts of the proposed project activities are likely to be minimal and tend to be positive. A clear understanding of these impacts may help communities understand and anticipate the effects of the proposed 2D seismic survey. One of the major possible impacts may be unrealistic job expectations about the proposed project. It is important for local communities to bear in mind that the proposed project activities will be temporary over a period of 3-4 months. The limited but temporary job opportunities will mainly be available for the debushing / widening of some of the areas along the survey lines, logistics and geophones deployment and recovery operations. The limited number of people that will 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. The EIA process combined with the field-based stakeholder mapping, consultation and engagement processes shall assess the broader socioeconomic aspects of the proposed 2D seismic survey and recommends mitigation measures in the EMP that will enhance the temporary socioeconomic benefits that the proposed 2D seismic survey may offer to the local communities.

5.4.2.6 Waste Management

Although very limited for a very short period of time, various types of wastes (liquids and solids) are likely to be generated mainly around the proposed campsite and along the survey lines/ profiles. The campsite will be equipped to handle both the liquid and solid waste likely to be generated. The campsite will be equipped with chemical toilets for the management of waste water with mobile toilets made available along the profiles/ survey lines. Waste bags for management of solid waste will be made available at the campsite and will also be carried along the survey lines and no litter shall be tolerated. Burial of solid waste around the campsite, along the survey lines or anywhere within or outside the PEL area is prohibited. All solid waste collected at the campsite and along the survey lines / profiles will only be disposed at an approved municipal facility at Rundu. Continuous debriefing and awareness of the survey team on all matters related to environmental management shall be undertaken.

5.4.3 Stakeholder Consultation Process

5.4.3.1 List of Potential Stakeholders

Risk-Based Solutions has identified the following stakeholder groups with respect to the proposed 2D seismic survey operation in PEL 73 as summarised in Table 5.:

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

(viii) Other interested parties.

Table 5.2: List of potential stakeholder.

STAKEHOLDER GROUP	STAKEHOLDERS CATEGORY
Central Government Ministries	Ministry of Mines and Energy (MME)
	Ministry of Environment, Forestry and Tourism (MEFT)
	Ministry Urban and Rural Development (MURD)
	Ministry of Agriculture, Water and Land Reform (MAWLR)
	Ministry of Industrialisation, Trade and SME Development
	Ministry of Labour, Industrial Relations and Employment Creation
Regional Government	Kavango West Regional Council
	Kavango East Regional Council
Local Government	Nkurenkuru Town Council
	Rundu Town Council
	Settlements in both Kavango West and West Regions where the proposed 2D seismic survey Lines may pass through
Traditional / Tribal Authorities	Kwangali
	Mbunza
	Shambyu
	Gciruku
	Mbukushu
State Owned Enterprises	Roads Authority (RA)
	Namibian Port Authority (NamPort)
	Others to be identified
Political Parties Representatives (Councillors)	South West Africa People's Organization (SWAPO)
	Official Oppositions Party
	Other Opposition Parties / Independent representatives
Trade Unions	All as may be applicable to the Project
Non-Profit Organisations and conservation organisations	National Non-Governmental Organisations (NGOs) and Community Based Organisations (CBOs)
Indigenous /Vulnerable / Marginalised Local Communities	To be identified
Print and Electronic Media Houses	Local Newspapers (New Era, The Namibian, Republikein, Confidente, Windhoek Observer, Allgemeine Zeitung and other local newspapers), TV and radio stations
Project Contractors and Business Partners	Others to be identified
General public	Public opinion
Other International, Regional and Local Stakeholders	To be identifies as the Project Progress and during stakeholders consultation

5.4.3.2 Selection of the Appropriate Consultation Method

All engagement should proceed on the basis of what are culturally acceptable and appropriate methods for each of the different stakeholder groups and the following are the key examples on the choice / appropriate consultation method based on the experiences from previous projects undertaken in Namibia:

- ❖ Prepare formal project specific information dissemination presentations when consulting government (Central, Regional or Local Authority) officials.
- ❖ When dealing with communities, targeted meetings with a mixture of the use of posters, handouts leaflets, videos and formal interactive presentation that allows the participants to contribute, and.

- ❖ When working with an informal focus group discussion this shall be facilitated by posters, non-technical pamphlets and other visual presentation aids including models and videos.

There are a variety of engagement techniques used to build relationships with stakeholders, gather information from stakeholders, consult with stakeholders, and disseminate project information to stakeholders. When selecting an appropriate consultation technique, culturally appropriate consultation methods, and the purpose for engaging with a stakeholder group should be considered. Table 5.3 provides a detailed assessment of the engagement methods that will be adopted as applicable.

Table 5.3: Assessment of potential appropriate engagement method and associated activities.

ENGAGEMENT METHOD	MOST APPROPRIATE PUBLIC / STAKEHOLDER ENGAGEMENT ACTIVITIES
Print media / Newspaper advertisement / notices / Articles	❖ Publish advertisements / notices / articles in local newspapers about the proposed project and consultation activities being undertaken
Social media	❖ Facebook, twitter, WhatsApp and other media platforms
Correspondence by formal letters phone /email/Text/Instant messaging/ Voice or Video Conferencing/ Information Seminars	<ul style="list-style-type: none"> ❖ Distribute project information to government officials, organisations, agencies and companies ❖ Invite stakeholders to meetings ❖ Arrange a Voice or Video Conferencing ❖ Information seminars
Radio announcements	<ul style="list-style-type: none"> ❖ Disseminate project information to large audiences, and rural stakeholders ❖ Inform stakeholders about consultation meetings
One-on-one interviews	<ul style="list-style-type: none"> ❖ Solicit views and opinions ❖ Enable stakeholders to speak freely and confidentially about controversial and sensitive issues ❖ Build personal relations with stakeholders especially community influencers ❖ Recording of interviews
Formal / Informal poster / meetings session	<ul style="list-style-type: none"> ❖ Present project information to a group of stakeholders ❖ Facilitate meetings using PowerPoint presentations, posters, models, videos and pamphlets or project information documents ❖ Allow the group of stakeholders to provide their views and opinions ❖ Build impersonal relations with high level stakeholders ❖ Distribute technical documents ❖ Record discussions, comments/questions raised and responses
Public meetings	<ul style="list-style-type: none"> ❖ Present project information to a large audience of stakeholders, and in particular communities / town halls / open village settings ❖ Allow the group of stakeholders to provide their views and opinions ❖ Build relationships with neighbouring communities ❖ Distribute non-technical project information ❖ Facilitate meetings using PowerPoint presentations, posters, models, videos and pamphlets or project information documents ❖ Record discussions, comments/questions raised and responses
Workshops	<ul style="list-style-type: none"> ❖ Present project information to a group of stakeholders ❖ Allow the group of stakeholders to provide their views and opinions ❖ Use participatory exercises to facilitate group discussions, brainstorm issues, analyse information, and develop recommendations and strategies ❖ Recording of responses
Focus group meetings	<ul style="list-style-type: none"> ❖ Allow a smaller group of between 8 and 15 people to provide their views and opinions of targeted baseline information ❖ Build relationships with neighbouring communities ❖ Use a focus group interview guideline to facilitate discussions ❖ Record responses
Surveys	<ul style="list-style-type: none"> ❖ Gather opinions and views from individual stakeholders ❖ Gather baseline data ❖ Record data ❖ Develop a baseline database for monitoring impacts

5.4.3.3 Stakeholder Engagement Schedule

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

- (i) Pre-survey scouting in order to assess accessibility and confirm the line survey scouting to be included in the EIA Process undertaken during the month of December 2020.
- (ii) EIA and EMP Permitting process to be undertaken in January 2021.
- (iii) Planning and mobilisation (Tracks / roads preparation (Clearing and widening) to be undertaken before implementation in 2021.
- (iv) Data acquisition (Actual Survey) to be undertaken before implementation in 2021, and.
- (v) Demobilisation and survey completion to be undertaken before implementation in 2021.

5.4.3.4 EIA and EMP Public and Stakeholder Consultation Meetings Schedule

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

- (i) Kavango West Region, Nkurenkuru, Nkurenkuru Community Hall, Wednesday, 20th January 2021, Morning Session from 10hrs00 to 13hrs00 Formal Meeting and Afternoon Session from 15hrs00 to 18hrs00 Open Sessions Public walk in as needed.
- (ii) Kavango East Region, Rundu, AMTA, Friday 22nd January 2021, Morning Session from 10hrs00 to 13hrs00 Formal Meeting and Afternoon Session from 15hrs00 to 18hrs00 Open Sessions Public walk in, and.
- (iii) Field-based public / local villages community meetings and poster sessions at key settlements such as Ncamagoro, Gcuru, Ncuncuni, Cuma, Mbambi, Ncaute and Kawe, all situated along the various seismic survey lines. The field-based meetings / sessions will be undertaken in coordination with the regional councillors and traditional authorities from Saturday 23rd to Monday 25th January 2021.

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

5.5 Proposed EIA Assessment of Likely Impacts

5.5.1 Severity Criteria for Environmental Impacts

In evaluating the severity of potential environmental impacts likely to be associated with the proposed 2D seismic survey operations, the following factors shall be taken into consideration:

- ❖ Receptor/ Resource Characteristics: The nature, importance and sensitivity to change of the receptors / target or resources that could be affected.
- ❖ Impact Magnitude: The magnitude of the change that is induced.
- ❖ Impact Duration: The time period over which the impact is expected to last.

- ❖ Impact Extent: The geographical extent of the induced change, and.
- ❖ Impact Severity: The severity of an impact is a function of a range of considerations.
- ❖ Likelihood of Occurrence (Probability): How likely is the impact to occur? and.
- ❖ Regulations, Standards and Guidelines: The status of the impact in relation to regulations (eg. discharge limits), standards (eg. environmental quality criteria) and guidelines.

The overall impact severity has been categorised using a subjective scale as shown in Table 5.4 for magnitude, Table 5.5 for duration and Table 5.6 for extent.

Table 5.4: Scored on a scale from 0 to 5 for impact magnitude.

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 5.5: Scored time period over which the impact is expected to last.

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

Table 5.6: 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

5.5.2 Likelihood (Probability) of Occurrence

The likelihood (probability) of the pre-identified events occurring has been ascribed using a qualitative scale of probability categories (in increasing order of likelihood) as shown in Table 5.7. Likelihood is estimated on the basis of experience and/ or evidence that such an outcome has previously occurred. Impacts resulting from routine/planned events (i.e., normal operations) are classified under category (E).

Table 5.7: 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 (egg 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 occurs several times per year at each location where such works are undertaken)

5.5.3 Impact Assessment Process

5.5.3.1 Overview

The overall impact assessment adopted the Leopold matrix framework which is one of the internationally best-known matrix assessment methodology available for predicting the impact of a project on the receiving environment. The assessment process took into considerations the proposed activities, trade-offs, alternatives, and issues to be considered as outlined in Table 1.1. Further inputs were provided by specialist consultants.

5.5.3.2 Evaluation of Project Activities Impacts

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

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

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

- (i) Impact Severity: The severity of an impact is a function of a range of considerations, and.
- (ii) 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 with respect to the impact duration, geographical extent and probability occurrence have been categorised using a semi quantitative approach and presented as shown in Table 5.8.

Table 5.8: Impact assessment matrix used for assessing the overall likely impacts that the proposed 2D seismic survey activities on the receiving environment sensitivity (physical, biological, socioeconomic, cultural, and archaeological environments) with respect to duration, geographical extent, and probability occurrence.

RECEIVING ENVIRONMENT SENSITIVITY			PHYSICAL ENVIRONMENT						BIOLOGICAL ENVIRONMENT					SOCIOECONOMIC, CULTURAL, AND ARCHAEOLOGICAL ENVIRONMENT					
SENSITIVITY RATING		CRITERIA	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 Forestry	Tourism and Recreation	Cultural, Biological and Archaeological Resources	
1	Negligible	The receptor or resource is resistant to change or is of little environmental value.																	
2	Low	The receptor or resource is tolerant of change without detriment to its character, is of low environmental or social value, or is of local importance.																	
3	Medium	The receptor or resource has low capacity to absorb change without fundamentally altering its present character, is of high environmental or social value, or is of national importance																	
4	High	The receptor or resource has moderate capacity to absorb change without significantly altering its present character, has some environmental or social value, or is of district/regional importance.																	
5	Very High	The receptor or resource has little or no capacity to absorb change without fundamentally altering its present character, is of very high environmental or social value, or is of international importance.																	
SOURCES OF POTENTIAL IMPACT			ROUTINE AND PHYSICAL PRESENCE OPERATIONAL ACTIVITIES		1.	Planning and mobilisation (Pre-survey preparation)													
					2.	Camp sites setups and widening of tracks and creation of limited new access as may be applicable													
					3.	Actual data acquisition along the individual profiles / survey lines													
					4.	Demobilisation and Closure (Survey Completion)													
			UNPLANNED ACCIDENTAL EVENTS		5.	Any accidental event that may be associated with the routine and physical presence operational activities													

5.5.4 Assessment of the Overall Significant Impacts

5.5.4.1 Overview

The determination of the significance of the negative impacts / key issues caused by the proposed 2D seismic survey activities as key sources of such impact has been based on the environmental baseline results and the intensity of the likely negative impact. The assessment focused on the degree to which the proposed project activities are likely to result in unwanted consequences on the receptor covering the receiving environment (natural, built, socioeconomic, flora, fauna, habitat, and ecosystem).

5.5.4.2 Summary of the Sources of Impacts

The main key sources of impacts that have been used in the determination of the significant impacts / key issues posed by the proposed 2D seismic survey activities covering the planning and mobilisation (Pre-survey preparation), camp sites setups and widening of tracks and creation of limited new access as may be applicable, actual data acquisition along the individual profiles / survey lines, demobilisation and closure (Survey completion) and any accidental event that may be associated with the routine and physical presence operational activities. Each of the main sources of impacts have been evaluated against the receiving environment as potential receptors with respect to potential pathways.

5.5.4.3 Determination of the Overall Likely Significant Impacts

To determine the overall significant impact for each individual source associated with the proposed 2D seismic survey activities, an impact identification and assessment process has been undertaken as part of the EIA.

The EIA impact identification and assessment processes focused on the environment interaction approach with respect to the proposed 2D seismic survey activities, alternatives and the likely targets or receptor / key issues linked to a specific pathways.

The results of the overall significant impacts assessment associated with the proposed 2D seismic survey activities / sources of potential impacts of significant impacts with respect to the receiving environment that could potentially be affected, resulting in key issues are presented in as shown in Table 5.9.

Table 5.9: Assessment matrix used for assessing the likely significant impacts with respect to proposed 2D seismic survey activities on the receiving environment (physical, biological, socioeconomic, cultural, and archaeological environments).

IMPACT SEVERITY <div>Magnitude, Duration, Extent, Probability</div>			RECEPTOR CHARACTERISTICS (SENSITIVITY)					PHYSICAL ENVIRONMENT						BIOLOGICAL ENVIRONMENT					SOCIOECONOMIC, CULTURAL, AND ARCHAEOLOGICAL ENVIRONMENT				
			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	ROUTINE AND PHYSICAL PRESENCE OPERATIONAL ACTIVITIES	1.	Planning and mobilisation (Pre-survey preparation)																	
		2.	Camp sites setups and widening of tracks and creation of limited new access as may be applicable																	
		3.	Actual data acquisition along the individual profiles / survey lines																	
		4.	Demobilisation and Closure (Survey Completion)																	
	UNPLANNED ACCIDENTAL EVENTS	5.	Any accidental event that may be associated with the routine and physical presence operational activities																	

5.6 EIA and EMP Reporting

5.6.1 Overview

This detailed Environmental Scoping Report with Terms of Reference (ToR) has been prepared for the proposed 2D seismic survey operations over the areas of interest in PEL 73. The Environmental Scoping Report will be followed by the EIA and EMP Reports that will support the application for Environmental Clearance Certificate (ECC) for the proposed survey operations.

5.6.2 EIA Reporting

The EIA Report shall provide an assessment of both positive and negative impacts likely to be associated with the proposed 2D seismic survey operations.

Potential receiving environmental (physical, biological and socioeconomic) effects shall be assessed in relation to the baseline conditions, i.e. the conditions that would prevail should the proposed 2D seismic survey operations not proceed. For the purpose of this assessment, receptors are defined as elements of the natural or human environment which may interact with, or be interacted by, the proposed project activities.

Baseline conditions are those that existed at the time of the assessment. It is recognised that some receptors and resources may be more vulnerable to change or to have greater importance than others.

Within the project areas of influence importance and sensitivity of receptors (physical, biological and socioeconomic) shall be determined based on professional judgement and considering the following:

- ❖ Relevant legislative or policy standards or guidelines.
- ❖ Relative importance/value assigned to existing social or environmental features and receptors.
- ❖ Capacity of the receptor to absorb change, and.
- ❖ Capacity of the receptor to recover from change.

The following specialist studies shall be considered as part of the EIA Process:

- ❖ Field-based fauna and flora assessment, and.
- ❖ Review of the existing socioeconomic archaeological, vibrations, dust, and noise reports and other as may be proposed by stakeholders during the consultation process.

5.6.3 EMP Reporting

5.6.3.1 Overview

The following approach shall be used regarding the need for mitigation measures on the assessed key issues to be actively addressed in the EMP Report and to be implemented and monitored by the Proponent:

- ❖ If environmental aspects are evaluated to be of low significance, they do not require specific management plans, and need not be actively addressed in the EMP (although they may still be listed and reported on).
- ❖ A decision on the need to actively address any issue with a "Medium" significance ranking will require consideration of other relevant factors, such as the nature of the impact, risks associated with possible cumulative aspects, and the degree of concern of stakeholders, and.
- ❖ If environmental aspects receive a "High" significance ranking, they must be addressed by means of active management, mitigation or rehabilitation measures.

For each negative impact of high or medium significance, mitigation objectives will be set (i.e. ways of reducing negative impacts), and attainable management actions will subsequently be addressed in the EMP Report for the proposed 2D seismic survey operations.

Without management, these impacts would either breach statutory limits or be unacceptable to statutory authorities or to stakeholders, as they would result in a significant deterioration of one or more environmental resources or components.

5.6.3.2 Hierarchy of Mitigation Measures Implementation

The overall outcomes of the environmental assessment process will be to prepare mitigation measures to be detailed in the EMP Report. A hierarchy of methods for mitigating significant adverse effects adopted for this environmental assessment and in order of preference are as follows:

- (i) Enhancement, e.g. provision of new habitats.
- (ii) Avoidance, e.g. sensitive design to avoid effects on ecological receptors.
- (iii) Reduction, e.g. limitation of effects on receptors through design changes. and
- (iv) Compensation, e.g. community or environmental benefits.

The EMP will provide a detailed plan of action required in the implementation of the mitigation measures for minimising and maximising the identified negative and positive impacts respectively. The EMP shall also provide the management actions with roles and responsibilities requirements for implementation of environmental management strategies by the Proponent.

5.6.3.3 General Mitigation Measures Implementation

The EMP shall provide a detailed plan of actions required in the implementation of the mitigation measures for minimising and maximising the identified negative and positive impacts respectively. The EMP shall also provide for the management actions with roles and responsibilities requirements for implementation of environmental management strategies by the Proponent through the Contractors and Subcontractors who will be undertaking the proposed 2D seismic survey operations. The EMP shall give commitments including financial and human resources provisions for effective management of the likely environmental liabilities during and after the implementation of the proposed 2D seismic surveys.

Based on the findings of this Scoping work, the following is the summary list of the key general mitigation measures that shall be reviewed and elaborated during the preparation of the EMP Report and to be implemented by the Proponent:

1. Implementation of the EMP.
2. Public and stakeholders relations.
3. Measures to enhance positive socioeconomic impacts.
4. Environmental awareness briefing and training.
5. Mitigation measures on Fly Camp operations.
6. Use of existing access roads, tracks and general vehicle movements.
7. Mitigation measures for preventing flora destruction.
8. Mitigation measures for preventing faunal destruction.

9. Mitigation measures to be implemented with respect to the exploration camps and exploration sites.
10. Mitigation measures for surface and groundwater protection as well as general water usage.
11. Mitigation measures to minimise negative socioeconomic impacts.
12. Mitigation measures to minimise health and safety impacts.
13. Mitigation measures to minimise visual impacts.
14. Mitigation measures to minimise vibration, noise and air quality.
15. Mitigation measures for waste (solid and liquid) management.
16. Rehabilitation plan, and.
17. Environmental data collection.

5.6.3.4 EMP Roles and Responsibilities

Within the framework of the EMP, the Proponent shall provide for a corporate structure for the management of the environmental elements that may be affected by the different activities of the proposed 2D seismic survey operations. The EMP shall also identify the activity groups / environmental elements, the aspects / targets, the indicators, the schedule for implementation and who should be responsible for the management to prevent major impacts that the proposed 2D seismic survey activities may have on the receiving environment (physical and biological environments).

It is highly imperative that there is an effective and response organisational structure of the Proponent that shall defines the roles, responsibilities, and authority to implement the provisions of the EMP. An indicative summary of such a structure to be fully defined during the EMP process is shown in Fig. 5.4. Provision shall be made, on an ongoing basis, for sufficient management support and human and financial resources.

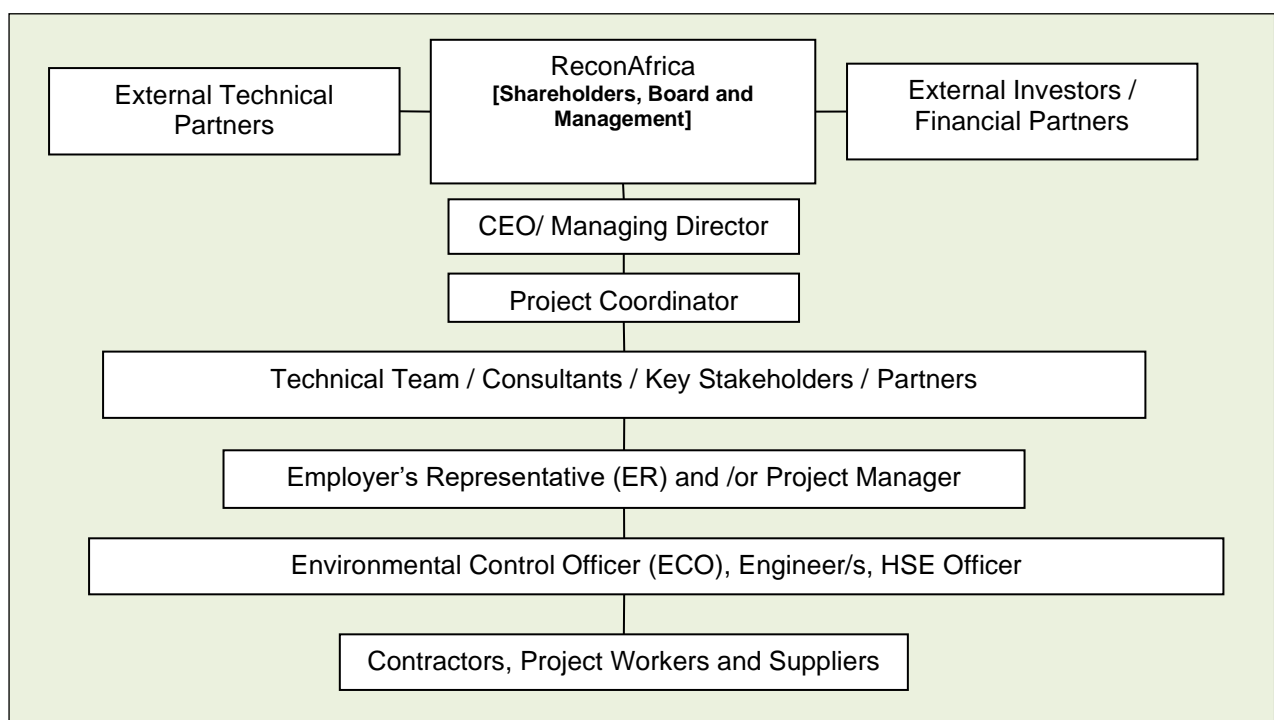


Figure 5.4: Indicative organisational structure of the Proponent that shall defines the roles, responsibilities, and authority to implement the provisions of the EMP.

6. SCOPING CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary of Conclusions

All human induced activities including the proposed 2D seismic survey operations, have the potential negative consequences on the receiving physical, biological, socioeconomic, cultural and archaeological environments. By identifying the most important sensitivity components of the receiving environment including high risk habitats beforehand, coupled with environmentally acceptable recommendations (mitigating factors), will lessen the overall negative impacts and improves the positive impacts of such proposed project activities.

Based on the findings of this Environmental Scoping report, it is hereby recommended that EIA and EMP reports shall be prepared to support the application for ECC for the proposed 2D seismic survey operations over the areas of interest within PEL 73. The EIA and EMP shall cover the whole proposed 2D seismic survey line coverages. The EIA and EMP process shall include the following site-specific specialist studies: Field-based flora and fauna and review of the existing water, archaeological, dust, noise, and socioeconomic assessments.

6.2 Summary of Recommendations

6.2.1 Key Terms of Reference (TOR) Issues

In meeting national regulatory the EA process covering this Scoping, EIA and EMP for the proposed 2D seismic survey operations shall address the following as key issues to be elaborated in detail in the EIA and EMP Reports and to be considered with respect to the receiving environment:

1. Assessment of the baseline environmental and social conditions.
2. Consideration of feasible environmentally and socially preferable alternatives for the proposed 2D seismic survey operations.
3. Requirements under host country laws and regulations, applicable international treaties and agreements including the 2015 Paris climate change agreement.
4. Protection and conservation of biodiversity (including endangered species and sensitive ecosystems in modified, natural and critical habitats) and identification of legally protected areas.
5. Use and management of dangerous substances.
6. Major hazards assessment and management.
7. Pollution prevention and waste minimisation, pollution controls (liquid effluents and air emissions), and waste management.
8. Greenhouse gas emissions level and emissions intensity.
9. Water usage, water intensity, water source.
10. Land cover, land use practices.
11. Consideration of physical climate risks and adaptation opportunities, and of viability of project operations under changing weather patterns/climatic conditions.
12. Cumulative impacts of existing projects, the proposed project, and anticipated future projects.
13. Consideration of actual or potential adverse human rights impacts and if none were identified, an explanation of how the determination of the absence of human rights risks was reached,

including which stakeholder groups and vulnerable populations (if present) were considered in their analysis.

14. Labour issues and occupational health and safety including radiation safety.
15. Consultation and participation of affected parties in the design, review and implementation of the Project.
16. Socio-economic impacts.
17. Impacts on affected communities, and disadvantaged or vulnerable groups.
18. Gender and disproportionate gender impacts.
19. Consent to the surface user rights and impacts on Indigenous Peoples, and their unique cultural systems and values including impacts to lands and natural resources subject to traditional ownership or under customary use.
20. Protection of cultural property, heritage and archaeological resources.
21. Protection of community health, safety and security (including risks, impacts and management of Project's use of security personnel), and.
22. Fire prevention and life safety.

The above potential environmental and social issues shall be reviewed, assessed and addressed in the EIA and EMP Reports in line with national legal frameworks.

The Constitution 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), the Environmental Protection Clause 11 of the Petroleum Agreement signed between ReconAfrica and the Government of the Republic of Namibia, and all other applicable national laws and Regulations with respect to water, land, energy, labour and health and safety all provides for the mechanism of assessing key issues associated with the proposed 2D seismic survey operations. The only key missing components to the regulatory frameworks in Namibia are benchmarks, limits, standards and guidelines with respect to gaseous, liquid and solid emissions. However, in the absence of the national gaseous, liquid and solid emission limits for Namibia, the proposed project shall target the Multilateral Investment Guarantee Agency (MIGA) gaseous effluent emission level and liquid effluent emission levels. Noise abatement measures must target to achieve MIGA guidelines.

6.2.2 Public Consultations

Public and stakeholder consultation and engagement process shall be implemented by the Proponent. According to the Environmental Impact Assessment (EIA) Regulations No. 30 of 2012 and the Environmental Management Act, (EMA), 2007, (Act No. 7 of 2007), a person conducting a public consultation process must give notice to all potential interested and affected parties of the application which is subjected to public consultation. The EIA Regulations clearly state that potential interested and affected parties must be provided with a reasonable opportunity (21 days) to comment on the application under section 21(6) of the EIA Regulations. In line with the provisions of the regulations, advertisements will be published in the local newspapers. The overall objectives of publishing the adverts in the local newspapers will be to inform and notify all the Interested and Affected Parties (I&AP) about the proposed 2D seismic survey operations.

6.2.3 Summary of the Field-Based Specialist Studies

Fauna and flora field-based specialist studies shall be undertaken as well as review of the existing socioeconomic archaeological, vibrations, dust, and noise reports and other assessment as may be proposed by stakeholders during the consultation process and applicable and relevant to the proposed 2D seismic survey operations.

7. BIBLIOGRAPHY

1. GENERAL

Bechstadt, T., Jager, H., Spence, G., Werner, G., 2012. Late Cryogenian (Neoproterozoic) glacial and post-glacial successions at the southern margin of the Congo Craton, northern Namibia: facies, palaeogeography and hydrocarbon perspective, Geological Society, London, Special Publications, 2012, 368:381-393

Boocock, C., & Van Straten, O. J. 1962. Notes on the geology and hydrology of the central Kalahari region, Bechuanaland Protectorate. Transactions of the South African Geological Survey 65, p125-171.

CSIR, 1982. Final report on the geophysical and hydrogeological investigation of the groundwater of Hereroland, South West Africa.

Department of Water Affairs and Forestry, 2001. Groundwater in Namibia: An explanation to the hydrogeological map. MAWRD, Windhoek, 1, 128 pp.

De Swardt, A. M. J. & Bennet, G. 1974. Structural and physiographic evolution of Natal since the late Jurassic. Transactions of the Geological Society of South Africa 77, p309-22.

DWA. 1997. Report on the hydrogeological investigation to determine the groundwater potential in the Goblenz Area.

First African Oil Corporation, 2005. Preliminary evaluation of the hydrocarbon potential of the Etosha (Owambo) Basin, Namibia. Internal report. Ministry of Mines and Energy.

Frimmel, H.E., Klotzli, U., Siegfried, P. 1996b. New Pb-Pb single zircon age constraints on the timing of Neoproterozoic glaciation and continental break-up in Namibia. Journal of Geology, **v 104**, pp. 459-469.

Forster, S. D. 1987. Fundamental concepts in aquifer vulnerability, pollution risk and protection strategy. In: van Duijvenhooeden W, Van Waegeningh HG (eds) Proceedings and information in vulnerability of soil and groundwater to pollutants, vol. 38. TNO committee on hydrological research, the Hage, pp 69-86.

Geological Survey of Namibia, 1999. Regional geological map of Namibia. Ministry of Mines and Energy, Windhoek, Namibia.

Gray, D. R., Foster, D. A., Meert, J. G., Goscombe B. D., Armstrong, R., Trouw, R. A., Passchier, W. 2008. A Damara orogen perspective on the assembly of southwestern Gondwana. Geological Society of London, Special Publications, **v 294**, pp. 257- 278

Hoak, T. E., Klawitter, A. L., Dommer, C. F., and Scaturro, P. V., 2014. Integrated exploration of the Owambo Basin, onshore Namibia: hydrocarbon exploration and implications for a modern frontier basin. Search and Discovery article, 10609, 6-9..

Jones, M, J. 2010. Groundwater hydrology of the Okavango Basin: Transboundary diagnostic Analysis technical report.

Kamona, A.F., and Gunzel, A. 2007. Stratigraphy and base metal mineralization in the Otavi Mountain Land, Northern Namibia: A review and regional interpretation, Godwana Research, **v 11**, 396-413.

Kuells, C. 2000. Resolving patterns of groundwater flow by inverse hydrochemical modelling in semi-arid Kalahari Basin. Unpublished PHD thesis.

Miller, R.McG. 1997. The Owambo basin of northern Namibia, 237-317. In: Selley, R.C. (Ed) Sedimentary Basins of the World: African Basins, Elsevier, Amsterdam, 394 p.

- Miller, R.McG., 1992. Petroleum and Natural Gas. The mineral resource of Namibia, Geological Survey of Namibia, Ministry of Mines and Energy, Windhoek, 7.3-22.
- Miller, R.McG., 2008. The geology of Namibia: Neoproterozoic to Lower Palaeozoic, Geological Survey of Namibia, Windhoek, v 2.
- Miller, R., McG., Pickford M., and Senut, B., 2010. The Geology, Palaeontology and Evolution of the Etosha Pan, Namibia: Implications for terminal Kalahari Deposition. South African Journal of Geology, Vol. 113, p. 307-334,
- Moore, C.H. 2001. Carbonate reservoirs. Porosity evolution and diagenesis in a sequence stratigraphic framework. Developments in sedimentology, Elsevier, Amsterdam, v 55, pp. 341-355.
- Monk D.J, Ross J. and Mooney B. 2004, A new look and an old source: Presented at the CSEG Natuional Convention 2004.
- NamWater. 2018. Drilling of six production borehole at the Katji na Katji water supply scheme.
- Oriard L.L 1994. Vibroseis operations in an urban environment: Bulletin Association Engineering Geologists 31(3): 343-366.
- Oriard L.L 1999. The effect of vibrations and engineering forces: International Society of Explosive Engineering, Cleveland, OH, 284 p.
- Oriard L.L 2002. Explosive engineering, construction vibrations and geotechnology: International Society of Explosive Engineering, Cleveland, OH, 680 p.
- Overseas Petroleum and Investment Corporation, 1991. Geological report on the OPO-1 Well, Etosha Basin, Exploration Report.
- Shaw, P. A., & Thomas, D, S, G. 1990. Geomorphological processes, environmental change and landscape sensitivity in the Kalahari Region of Southern Africa.
- Summerfield, M. A. 1985. Plate tectonics and landscape development on the African Continent. Boston, p27-51.
- Teasdale, D. L., Kiker, J. L., Oriard, L. L., Dowding, C. H., & Morrison, S. J. 2006. Response of test house to vibroseis vibrations and environmental forces. Environmental and Engineering Geoscience, 12(1), 25-37.
- Tucker, M.E., and Wright V.P. 1990. Carbonate Sedimentology. Blackwell Scientific Publications.
- ReconAfrica, 2020. The elephant in Namibia, Kavango Basin research report, Canada.
- Wanke, H & Wanke, A. 2007. Lithostratigraphy of the Kalahari Group in northern Namibia. Journal of African Earth Sciences 48 (2007), p314-328

2. FURTHER READING ON FAUNA AND FLORA

- Alexander, G. and Marais, J. 2007. A guide to the reptiles of southern Africa. Struik Publishers, Cape Town, RSA.
- Barnard, P. 1998. Underprotected habitats. In: Barnard, P. (ed.). Biological diversity in Namibia: a country study. Windhoek: Namibian National Biodiversity Task Force.
- Bester, B. 1996. Bush encroachment – A thorny problem. *Namibia Environment* 1: 175-177.

- Branch, B. 1998. Field guide to snakes and other reptiles of southern Africa. Struik Publishers, Cape Town, RSA.
- Branch, B. 2008. Tortoises, terrapins and turtles of Africa. Struik Publishers, Cape Town, RSA.
- Boycott, R.C. and Bourquin, O. 2000. The Southern African Tortoise Book. O Bourquin, Hilton, RSA.
- Broadley, D.G. 1983. Fitzsimons' Snakes of southern Africa. Jonathan Ball and AD. Donker Publishers, Parklands, RSA.
- Buys, P.J. and Buys, P.J.C. 1983. Snakes of Namibia. Gamsberg Macmillan Publishers, Windhoek, Namibia.
- Carruthers, V.C. 2001. Frogs and frogging in southern Africa. Struik Publishers, Cape Town, RSA.
- Channing, A. 2001. Amphibians of Central and Southern Africa. Protea Bookhouse, Pretoria, RSA.
- Channing, A. and Griffin, M. 1993. An annotated checklist of the frogs of Namibia. *Madoqua* 18(2): 101-116.
- Cole, D.T. and Cole, N.A. 2005. Lithops Flowering Stones. Cactus and Co. Libri
- Craven, P. (ed.). 1998. A checklist of Namibian plant species. Southern African Botanical Diversity Network Report No. 7, SABONET, Windhoek.
- Crouch, N.R., Kloppe, R.R., Burrows, J.E. and Burrows, S. M. 2011. Ferns of southern Africa – a comprehensive guide. Struik Nature, Cape Town, RSA.
- Cunningham, P.L. 1998. Potential wood biomass suitable for charcoal production in Namibia. *Agri-Info* 4(5): 4-8.
- Cunningham, P.L. 2006. A guide to the tortoises of Namibia. Polytechnic of Namibia, Windhoek, Namibia.
- Cunningham, P.L. 2018. Vertebrate fauna and flora expected in the PEL 73 (Blocks 1819 and 1820), Kavango East area. Unpublished report, Risk Based Solutions, Windhoek, Namibia.
- Cunningham, P.L. and Adank, W. 2005. *Chamaeleo dilepis* Leach, 1819. Flap-neck Chameleon. Prey. *African Herp News* 38: 19-20.
- Curtis, B. and Barnard, P. 1998. Sites and species of ecological, economic or archaeological importance. In: Barnard, P. (ed.). Biological diversity in Namibia: a country study. Windhoek: Namibian National Biodiversity Task Force.
- De Cauwer, V., Muys, B., Revermann, R. & Trabucco, A. 2014. Potential, realised, future distribution and environmental suitability for *Pterocarpus angolensis* DC in southern Africa. *Forest Ecology and Management* 315: 211-226.
- De Graaff, G. 1981. The rodents of southern Africa. Buterworths, RSA.
- Du Preez, L. and Carruthers, V. 2009. A complete guide to the frogs of southern Africa. Struik Publishers, Cape Town, RSA.
- Edwards, S., Portas, R., Hanssen, L., Beytell, P., Melzheimer, J., and Stratford, K. 2017. The spotted ghost: Density and distribution of serval *Leptailurus serval* in Namibia. *African Journal of Ecology* 2018(00): 1-10.
- Estes, R.D. 1995. The behaviour guide to African mammals. Russel Friedman Books, Halfway House, RSA.

- Garstang, M., Larom, D., Raspet, R. and Lindeque, M. 1995. Atmospheric controls on elephant communication. *The journal of experimental biology* 198: 939-951.
- Giess, W. 1971. A preliminary vegetation map of South West Africa. *Dinteria* 4: 1 – 114.
- Griffin, M. 1998a. Reptile diversity. In: Barnard, P. (ed.). Biological diversity in Namibia: a country study. Windhoek: Namibian National Biodiversity Task Force.
- Griffin, M. 1998b. Amphibian diversity. In: Barnard, P. (ed.). Biological diversity in Namibia: a country study. Windhoek: Namibian National Biodiversity Task Force.
- Griffin, M. 1998c. Mammal diversity. In: Barnard, P. (ed.). Biological diversity in Namibia: a country study. Windhoek: Namibian National Biodiversity Task Force.
- Griffin, M. 2003. Annotated checklist and provisional national conservation status of Namibian reptiles. Ministry of Environment and Tourism, Windhoek.
- Griffin, M. and Coetzee, C.G. 2005. Annotated checklist and provisional national conservation status of Namibian mammals. Ministry of Environment and Tourism, Windhoek.
- Hebbard, S. n.d. A close-up view of the Namib and some of its fascinating reptiles. ST Promotions, Swakopmund, Namibia.
- IUCN, 2020. IUCN Red List of threatened species. Version 2020.2. www.iucn.redlist.org. IUCN, Gland, Switzerland.
- Joubert, E. and Mostert, P.M.K. 1975. Distribution patterns and status of some mammals in South West Africa. *Madoqua* 9(1): 5-44.
- Knott, K. and Curtis, B. 2006. Aromatic resins from *Commiphora* trees. *Roan News Special Anniversary Edition* 2006: 22-24.
- Little, R., Crowe, R. and Barlow, S. 2011. Gamebirds of Southern Africa. Struik Nature, Cape Town, RSA.
- Mannheimer, C. and Curtis, B. (eds) 2018. Le Roux and Müller's field guide to the trees and shrubs of Namibia. Macmillan Education Namibia, Windhoek.
- Marais, J. 1992. A complete guide to the snakes of southern Africa. Southern Book Publishers, Witwatersrand University Press, Johannesburg, RSA.
- Mendelsohn, J., Jarvis, A., Roberts, A. and Robertson, T. 2002. Atlas of Namibia. A portrait of the land and its people. David Philip Publishers, Cape Town, RSA.
- Monadjem, A., Taylor, P.J., F.P.D. Cotterill and M.C. Schoeman. 2010. Bats of southern and central Africa. Wits University press, Johannesburg, RSA.

- Mortimer, B., Rees, W. L., Koelemeijer, P. and Nissen-Meyer, T. 2018. Classifying elephant behaviour through seismic vibrations. *Current Biology* 28(9): 547-548.
- Müller, M.A.N. 1984. Grasses of South West Africa/Namibia. John Meinert Publishers (Pty) Ltd, Windhoek, Namibia.
- Müller, M.A.N. 2007. Grasses of Namibia. John Meinert Publishers (Pty) Ltd, Windhoek, Namibia.
- O'Connell-Rodwell, C.E. 2007. Keeping an "ear" to the ground: seismic communication in elephants. *Physiology* 22(4): 287-294.
- O'Connell-Rodwell, C.E., Wood, J.D., Kinzley, C., Rodwell, T.C., Poole, J.H., and Puria, S. 2007. Wild African elephants (*Loxodonta africana*) discriminate between familiar and unfamiliar conspecific seismic alarm calls. *The Journal of the Acoustical Society of America* 122(2): 823-830.
- Passmore, N.I. and Carruthers, V.C. 1995. South African Frogs - A complete guide. Southern Book Publishers, Witwatersrand University Press, Johannesburg, RSA.
- Peacock, F. 2015. Chamberlain's LBJ's – the definitive guide to Southern Africa's little brown jobs. Paavo Publishing, South Africa.
- Picker, M. and Griffiths, C. 2011. Alien and invasive animals – a South African perspective. Struik Nature, Cape Town.
- Robertson, A. and Jarvis, A.M. 2000. Oxpeckers in north-eastern Namibia: recent population trends and the possible negative impacts of drought and fire. *Biological Conservation* 92: 241-247.
- Rothmann, S. 2004. Aloes – aristocrats of Namibian flora. ST Promotions, Swakopmund, Namibia.
- SARDB, 2004. CBSG Southern Africa. In: Griffin, M. 2005. Annotated checklist and provisional national conservation status of Namibian mammals. Ministry of Environment and Tourism, Windhoek.
- Schultz, M. and Rambold, G. 2007. Diversity shifts and ecology of soil lichens in central Namibia. Talk, Ecological Society of Germany, Austria and Switzerland (GfÖ), 37th Annual Meeting, Marburg: 12/9/2007 to 15/9/2007.
- Schultz, M., Zedda, L. and Rambold, G. 2009. New records of lichen taxa from Namibia and South Africa. *Bibliotheca Lichenologica* 99: 315-354.
- Simmons R.E. 1998a. Areas of high species endemism. In: Barnard, P. (ed.). Biological diversity in Namibia: a country study. Windhoek: Namibian National Biodiversity Task Force.
- Simmons, R.E. 1998b. Important Bird Areas (IBA's) in Namibia. In: Barnard, P. (ed.). Biological diversity in Namibia: a country study. Windhoek: Namibian National Biodiversity Task Force.
- Simmons R.E., Brown C.J. and Kemper, J. 2015. Birds to watch in Namibia: red, rare and endemic species. National Biodiversity Programme, Windhoek.
- Skinner, J.D. and Smithers, R.H.N. 1990. The mammals of the southern African subregion. University of Pretoria, RSA.
- Skinner, J.D. and Chimimba, C.T. 2005. The mammals of the southern African subregion. Cambridge University Press, Cape Town, RSA.
- Stander, P. and Hanssen, L. 2003. Namibia large carnivore atlas. Unpublished Report, Ministry of Environment and Tourism, Windhoek.

- Stratford, K., Weise, F., Meltzheimer, J. and de Woronin-Britz, N. 2016. Observations of servals in the Highlands of central Namibia. *Cat News* 64: 14-17.
- Steyn, M. 2003. Southern Africa Commiphora. Bendor Place, Polokwane, South Africa.
- Tarboton, W. 2001. A guide to the nests and eggs of southern African birds. Struik Publishers, Cape Town, RSA.
- Taylor, P.J. 2000. Bats of southern Africa. University of Natal Press, RSA.
- Tolley, K. and Burger, M. 2007. Chameleons of southern Africa. Struik Nature, Cape Town, RSA.
- Van Oudtshoorn, F. 2012. Guide to grasses of southern Africa. Briza Publications, Pretoria, South Africa.
- Visser, J. 2010. Testudinidae, Speke's Hinged Tortoise (*Kinixys spekii*). *African Herp News* 51: 22-24.