# APP-00647

# AGRICULTURAL AND HOSPITALITY ACTIVITIES ON FARM CAMPBELLSDREI HARDAP REGION

## ENVIRONMENTAL ASSESSMENT SCOPING REPORT

**Assessed by:**

**Assessed for:**

**Alwyn van Straten**

February 2020

| | | |
|---|---|---|
| **Project:** | **AGRICULTURAL AND HOSPITALITY ACTIVITIES ON FARM CAMPBELLSDREI, HARDAP REGION: ENVIRONMENTAL ASSESSMENT SCOPING REPORT** | |
| **Report: Version/Date:** | Final<br>February 2020 | |
| **Prepared for: (Proponent)** | Alwyn van Straten<br>P.O. Box 32098<br>Windhoek<br>Namibia | |
| **Lead Consultant** | Geo Pollution Technologies (Pty) Ltd<br>PO Box 11073<br>Windhoek<br>Namibia | TEL.: (+264-61) 257411<br>FAX.: (+264) 88626368 |
| **Main Project Team:** | **André Faul**<br>(B.Sc. Zoology/Biochemistry); (B.Sc. (Hons) Zoology); (M.Sc. Conservation Ecology); (Ph.D. Medical Bioscience)<br>**Pierre Botha**<br>(B.Sc. Geology/Geography); (B.Sc. (Hons) Hydrology/Hydrogeology)<br>**Quzette Bosman**<br>(BA. Geography/Sociology); (BA Environmental Management)<br>**Jannie van der Merwe**<br>(B.Sc. Geology/Geography); (B.Sc. (Hons) Hydrology/Hydrogeology)<br>**Stefan Short**<br>Health and Safety Supervisor / GIS Technician | |
| **Cite this document as:** | Faul A, Botha P, Bosman Q, van der Merwe J, Short S; 2020 February; Agricultural and Hospitality Activities on Farm Campbellsdrei, Hardap Region: Environmental Assessment Scoping Report | |
| **Copyright** | Copyright on this document is reserved. No part of this document may be utilised without the written permission of Geo Pollution Technologies (Pty) Ltd. | |
| **Report Approval** |  <br>**André Faul**<br>**Conservation Ecologist** | |

I _____ hereby confirm that the project description contained in this report is a true reflection of the information which the Proponent has provided to Geo Pollution Technologies. All material information in the possession of the proponent that reasonably has or may have the potential of influencing any decision or the objectivity of this assessment is fairly represented in this report and the report is hereby approved.

Signed at Windhoek on the 25th day of February 2019.

Alwyn van Straten

740215 00022
ID Number

# EXECUTIVE SUMMARY

Alwyn van Straten requested Geo Pollution Technologies (Pty) Ltd to undertake an environmental assessment for the existing and proposed agricultural, tourism and hospitality activities on Farm Campbellsdrei (FMM/00137) near Stampriet in the Hardap Region. The proponent currently irrigates 29.5 ha citrus orchards and 21.1 ha lucerne fields. Irrigation is from six production boreholes, by means of centre pivot and micro-irrigation systems (borehole numbers: WD 317009, WDR 180002, WDR 180004, WDR 18080012, WDR 18080013 and WDR 18080014). To develop the tourism and hospitality potential of Campbellsdrei, a number of facilities are planned. These include guestrooms, a lodge, campsite, air-strip and related facilities. Responsible hunting and a range of activities like cycling and birding are also part of the plans.

The environmental assessment determines all environmental, safety, health and socio-economic impacts associated with the agricultural and tourism activities on the farm. Relevant environmental data was compiled by making use of secondary data and from a reconnaissance site visit. Potential environmental impacts and associated social impacts were identified and are addressed in this report.

The surrounding land use is agriculture, similar to Campbellsdrei. Due to the nature and location of the farm, limited impacts are expected on the surrounding environment, see summary impacts table below. Monitoring of environmental performance is recommended to ensure regulatory compliance and that corrective measures be taken if necessary. The agricultural activities on the farm plays a role in contributing to the agricultural and food sector by growing produce for local and international markets. Proposed guest accommodation and activities will contribute to Namibia's growing tourism and hospitality industry.

The major concerns related to the operations of the farm are that of potential groundwater, surface water and soil contamination, groundwater over-abstraction, the possibility of fire, ecological impacts, and health and safety of staff. By appointing local contractors and employees, and by implementing educational programs, the positive socio-economic impacts can be maximised while mitigating any negative impacts.

Maintaining a safety, health, environment and quality (SHEQ) policy will contribute to effective management procedures, to prevent and mitigate impacts. Adherence to all legislation and regulations on agriculture, tourism and hospitality, and health and safety, are paramount. All forms of soil and groundwater pollution must be prevented. Fire prevention is important. Fire response plans must be in place, and regular firefighting training provided. All staff should be educated on the importance of biodiversity and poaching or illegal harvesting of animal and plant products prohibited. A site-specific waste management plan can guide the disposal of both hazardous and non-hazardous waste. It should include waste reduction and recycling measures and the disposal of different forms of waste at appropriately classified waste disposal facilities. A monthly groundwater monitoring and review process is crucial and preferably in conjunction with other farmers in the area. This will act as an early warning system should over-abstraction occur, especially during dry seasons.

The environmental management plan included in Section 10 of this document acts as an on-site reference document, used during all phases (planning, construction, operations and decommissioning) of the farm. All monitoring and records kept should be reported on to ensure compliance with the environmental management plan. Parties responsible for transgression of the environmental management plan should be held responsible for any rehabilitation that may need to be undertaken. A health, safety, environment and quality policy must accompany the environmental management plan and the contents communicated to all employees and contractors. Adherence to local or national regulations and guidelines, as outlined in the environmental management plan, is important, and monitoring of the same must be performed.

## Impact Summary Class Values

| Impact Category | Impact Type | Construction | Operations |
|---|---|---|---|
| | *Positive Rating Scale: Maximum Value* | 5 | 5 |
| | *Negative Rating Scale: Maximum Value* | -5 | -5 |
| EO | Increased Crop Yield | | 3 |
| EO | Change in Land Use and Earning Potential | 3 | 3 |
| EO | Skills and Development | 2 | 2 |
| EO | Revenue Generation and Employment | 2 | 3 |
| SC | Demographic Profile and Community Health | -1 | -2 |
| SC | Traffic | -2 | -2 |
| SC | Health, Safety and Security | -2 | -2 |
| PC | Fire | -3 | -3 |
| PC | Waste Production | -2 | -2 |
| PC | Change in Soil Characteristics | -2 | -2 |
| BE | Ecosystem and Biodiversity Impact | -2 | 2 |
| PC | Groundwater and Surface Water | -3 | -3 |
| BE/EO | Groundwater Availability | | -3 |
| SC | Heritage | -3 | |

*BE = Biological/Ecological* *EO = Economical/Operational* *PC = Physical/Chemical* *SC = Sociological/Cultural*

# TABLE OF CONTENTS


**1 BACKGROUND AND INTRODUCTION ..... 1**

**2 SCOPE ..... 1**

**3 METHODOLOGY ..... 2**

**4 OPERATIONS AND RELATED ACTIVITIES ..... 3**

4.1 BACKGROUND ..... 3
4.2 AGRICULTURE ..... 3
*4.2.1 Pivot-Irrigation Systems ..... 4*
*4.2.2 Micro-sprayers ..... 5*
4.3 HOSPITALITY SECTOR ..... 5
4.4 GAME AND HUNTING ..... 6
4.5 WATER SUPPLY ..... 6
4.6 SUPPORT INFRASTRUCTURE ..... 6
*4.6.1 Power Supply ..... 7*
*4.6.2 Fuel Storage ..... 7*
*4.6.3 Solid Waste and Effluent Handling ..... 7*
*4.6.4 Storage and Maintenance Area ..... 8*
4.7 EMPLOYMENT ..... 8
4.8 GENERAL ..... 8

**5 ALTERNATIVES ..... 9**

5.1 PROJECT IMPLEMENTATION AND DESIGN ALTERNATIVES ..... 9
*5.1.1 Irrigation Methods ..... 9*
5.2 NO GO ALTERNATIVE ..... 12

**6 ADMINISTRATIVE, LEGAL AND POLICY REQUIREMENTS ..... 12**

**7 ENVIRONMENTAL CHARACTERISTICS ..... 16**

7.1 LOCALITY AND SURROUNDING LAND USE ..... 16
7.2 CLIMATE ..... 17
7.3 TOPOGRAPHY AND DRAINAGE ..... 18
7.4 SOIL ..... 18
7.5 GEOLOGY AND HYDROGEOLOGY ..... 19
7.6 PUBLIC WATER SUPPLY ..... 22
7.7 AGRO ECOLOGICAL ZONE ..... 23
7.8 ECOLOGY ..... 23
7.9 DEMOGRAPHIC AND ECONOMIC CHARACTERISTICS ..... 27
7.10 CULTURAL, HERITAGE AND ARCHAEOLOGICAL ASPECTS ..... 27

**8 PUBLIC CONSULTATION ..... 28**

**9 MAJOR IDENTIFIED IMPACTS ..... 28**

9.1 CHANGE IN LAND USE AND EARNING POTENTIAL ..... 28
9.2 SOCIO-ECONOMIC IMPACTS ..... 28
9.3 SURFACE WATER CONTAINMENT ..... 29
9.4 SOIL AND GROUNDWATER CONTAMINATION ..... 29
9.5 GROUNDWATER ABSTRACTION ..... 29
9.6 FIRE ..... 30
9.7 HEALTH AND SAFETY ..... 30
9.8 ECOSYSTEM AND BIODIVERSITY IMPACT ..... 30

**10 ASSESSMENT AND MANAGEMENT OF IMPACTS ..... 30**

10.1 RISK ASSESSMENT AND ENVIRONMENTAL MANAGEMENT PLAN ..... 32
*10.1.1 Planning ..... 33*
*10.1.2 Increased Crop Yield ..... 34*
*10.1.4 Change in Land Use and Earning Potential ..... 35*
*10.1.6 Skills and Development ..... 36*
*10.1.7 Revenue Generation and Employment ..... 37*

*10.1.8 Demographic Profile and Community Health* ..... *38*
*10.1.9 Traffic* ..... *39*
*10.1.10 Health, Safety and Security* ..... *40*
*10.1.11 Fire* ..... *41*
*10.1.12 Waste Production* ..... *42*
*10.1.13 Change in Soil Characteristics* ..... *43*
*10.1.14 Ecosystem and Biodiversity Impact* ..... *44*
*10.1.15 Groundwater and Surface Water Contamination* ..... *46*
*10.1.16 Groundwater Availability* ..... *48*
*10.1.17 Heritage* ..... *49*
*10.1.18 Cumulative Impact* ..... *50*
10.2 DECOMMISSIONING AND REHABILITATION ..... 51
10.3 ENVIRONMENTAL MANAGEMENT SYSTEM ..... 51

**11 CONCLUSION ..... 51**

**12 REFERENCES ..... 53**

## LIST OF APPENDICES

APPENDIX A: CERTIFICATES ..... 54
APPENDIX B: HYDROGEOLOGICAL SPECIALIST STUDY ..... 62
APPENDIX C: PROOF OF PUBLIC CONSULTATION ..... 63
APPENDIX D: COMMENTS AND RESPONSES TABLE ..... 69
APPENDIX E: COMMENTS RECEIVED DURING PUBLIC REVIEW OF THE EIA / EMP ..... 77
APPENDIX F: CONSULTANTS' CURRICULUM VITAE ..... 85

## LIST OF FIGURES

FIGURE 1. PROJECT LOCATION ..... 2
FIGURE 2. FARM LAYOUT ..... 9
FIGURE 3. PROPERTIES ADJACENT TO THE PROJECT AREA ..... 16
FIGURE 4. AVERAGE MONTHLY RAINFALL FOR THE AREA (ATLAS OF NAMIBIA) ..... 17
FIGURE 5. DOMINANT SOIL AND ROCK TYPES ..... 19
FIGURE 6. HYDROGEOLOGICAL MAP ..... 20
FIGURE 7. GROUNDWATER BASIN WITH RAINFALL AND INFERRED GROUNDWATER FLOW ..... 21
FIGURE 8. GROUNDWATER QUALITY ..... 22
FIGURE 9. ESTIMATED ENDEMISM IN NAMIBIA ..... 25
FIGURE 10. CONCEPTUAL GROUNDWATER BALANCE WITH OVER ABSTRACTION SCENARIO ..... 30

## LIST OF TABLES

TABLE 1. IRRIGATION SYSTEM EFFICIENCY (IWRM PLAN JOINT VENTURE NAMIBIA, 2010) ..... 10
TABLE 2. ALTERNATIVES CONSIDERED ON FARM CAMPBELLSDREI ..... 10
TABLE 3. NAMIBIAN LAW APPLICABLE TO THE DEVELOPMENT ..... 12
TABLE 4. RELEVANT MULTILATERAL ENVIRONMENTAL AGREEMENTS ..... 15
TABLE 5. STANDARDS OR CODES OF PRACTISE ..... 15
TABLE 6. ADJACENT FARMS ..... 17
TABLE 7. SUMMARY CLIMATE DATA ..... 17
TABLE 8. GROUNDWATER STATISTICS ..... 20
TABLE 9. GENERAL PLANT DATA OF THE SOUTHERN KALAHARI (DIGITAL ATLAS OF NAMIBIA) ..... 24
TABLE 10. GENERAL ANIMAL DATA OF THE LARGER AREA (DIGITAL ATLAS OF NAMIBIA) ..... 25
TABLE 11. TREES WITHIN QUARTER DEGREE SQUARES 2418AA AND 2418AB (CURTIS & MANNHEIMER 2005) ..... 26
TABLE 12. DEMOGRAPHIC CHARACTERISTICS OF THE MARIENTAL RURAL CONSTITUENCY, THE HARDAP REGION AND NATIONALLY (NAMIBIA STATISTICS AGENCY, 2011) ..... 27
TABLE 13. ASSESSMENT CRITERIA ..... 31
TABLE 14. ENVIRONMENTAL CLASSIFICATION (PASTAKIA 1998) ..... 32
TABLE 15. IMPACT SUMMARY CLASS VALUES ..... 52

## LIST OF PHOTOS

PHOTO 1. ORANGE TREES WITH MICRO-SPRAYERS AND HDPE PIPING ..... 4
PHOTO 2. LUCERNE UNDER CENTRE PIVOT IRRIGATION ..... 4
PHOTO 3. INSTALLATION OF PIPELINES AND RELATED INFRASTRUCTURE ..... 4
PHOTO 4. AREA CLEARED AND BEING PREPARED FOR PLANTING CITRUS TREES ..... 4
PHOTO 5. TYPICAL CENTRE PIVOT SYSTEM WITH FIXED CENTRAL TOWER (PHOCAIDES (2007) ..... 5
PHOTO 6. CENTRAL PIVOT SYSTEM PIPELINE ..... 5
PHOTO 7. CENTRAL PIVOT SYSTEM EMPLOYED IN THE REGION ..... 5
PHOTO 8. MICRO-SPRAYER ..... 5
PHOTO 9. OPERATIONAL MICRO-SPRAYER ..... 5
PHOTO 10. PROPOSED AREA FOR CAMPING SITE ..... 6
PHOTO 11. WATERING POINT FOR GAME ..... 6
PHOTO 12. 48 KW PHOTOVOLTAIC PLANT WITH PUMPHOUSE ..... 7
PHOTO 13. OLD ARTEFACTS FOUND ON FARM ..... 28

## LIST OF ABBREVIATIONS

| | |
|---|---|
| **AEZ** | Agro-Ecological Zone |
| **AIDS** | Acquired Immune Deficiency Syndrome |
| **BE** | Biological/Ecological |
| **DWA** | Department of Water Affairs |
| **EA** | Environmental Assessment |
| **EIA** | Environmental Impact Assessment |
| **EMA** | Environmental Management Act No 7 of 2007 |
| **EMP** | Environmental Management Plan |
| **EMS** | Environmental Management System |
| **EO** | Economic/Operational |
| **ES** | Environmental Classification |
| **GPT** | Geo Pollution Technologies |
| **HIV** | Human Immunodeficiency Virus |
| **IAPs** | Interested and Affected Parties |
| **IUCN** | International Union for Conservation of Nature |
| **LNAPL** | Light Non-Aqueous Phase Liquids |
| **mamsl** | Meters Above Mean Sea Level |
| **m/s** | Metre per second |
| **mbs** | Metres below surface |
| **MET** | Ministry of Environment and Tourism |
| **mm/a** | Millimetres per annum |
| **MSDS** | Material Safety Data Sheet |
| **NDP5** | Fifth National Development Plan |
| **PC** | Physical/Chemical |
| **PPE** | Personal Protective Equipment |
| **ppm** | Parts per million |
| **SANS** | South African National Standards |
| **SC** | Sociological/Cultural |
| **SHEQ** | Safety, Health, Environment and Quality |
| **UNFCCC** | United Nations Framework Convention on Climate Change |
| **WHO** | World Health Organization |

# GLOSSARY OF TERMS

**Alternatives** - A possible course of action, in place of another, that would meet the same purpose and need but which would avoid or minimize negative impacts or enhance project benefits. These can include alternative locations/sites, routes, layouts, processes, designs, schedules and/or inputs. The "no-go" alternative constitutes the 'without project' option and provides a benchmark against which to evaluate changes; development should result in net benefit to society and should avoid undesirable negative impacts.

**Assessment** - The process of collecting, organising, analysing, interpreting and communicating information relevant to decision making.

**Competent Authority** - means a body or person empowered under the local authorities act or Environmental Management Act to enforce the rule of law.

**Construction** - means the building, erection or modification of a facility, structure or infrastructure that is necessary for the undertaking of an activity, including the modification, alteration, upgrading or decommissioning of such facility, structure or infrastructure.

**Cumulative Impacts** - in relation to an activity, means the impact of an activity that in itself may not be significant but may become significant when added to the existing and potential impacts eventuating from similar or diverse activities or undertakings in the area.

**Environment** - As defined in the Environmental Assessment Policy and Environmental Management Act - "land, water and air; all organic and inorganic matter and living organisms as well as biological diversity; the interacting natural systems that include components referred to in sub-paragraphs, the human environment insofar as it represents archaeological, aesthetic, cultural, historic, economic, palaeontological or social values".

**Environmental Impact Assessment (EIA)** - process of assessment of the effects of a development on the environment.

**Environmental Management Plan (EMP)** - A working document on environmental and socio-economic mitigation measures, which must be implemented by several responsible parties during all the phases of the proposed project.

**Environmental Management System (EMS)** - An Environment Management System, or EMS, is a comprehensive approach to managing environmental issues, integrating environment-oriented thinking into every aspect of business management. An EMS ensures environmental considerations are a priority, along with other concerns such as costs, product quality, investments, PR productivity and strategic planning. An EMS generally makes a positive impact on a company's bottom line. It increases efficiency and focuses on customer needs and marketplace conditions, improving both the company's financial and environmental performance. By using an EMS to convert environmental problems into commercial opportunities, companies usually become more competitive.

**Evaluation** – means the process of ascertaining the relative importance or significance of information, the light of people's values, preference and judgements in order to make a decision.

**Hazard** - Anything that has the potential to cause damage to life, property and/or the environment. The hazard of a particular material or installation is constant; that is, it would present the same hazard wherever it was present.

**Interested and Affected Party (IAP)** - any person, group of persons or organisation interested in, or affected by an activity; and any organ of state that may have jurisdiction over any aspect of the activity.

**Mitigate** - The implementation of practical measures to reduce adverse impacts.

**Proponent (Applicant)** - Any person who has submitted or intends to submit an application for an authorisation, as legislated by the Environmental Management Act no. 7 of 2007, to undertake an

activity or activities identified as a listed activity or listed activities; or in any other notice published by the Minister or Ministry of Environment & Tourism.

**Public** - Citizens who have diverse cultural, educational, political and socio-economic characteristics. The public is not a homogeneous and unified group of people with a set of agreed common interests and aims. There is no single public. There are a number of publics, some of whom may emerge at any time during the process depending on their particular concerns and the issues involved.

**Scoping Process** - process of identifying: issues that will be relevant for consideration of the application; the potential environmental impacts of the proposed activity; and alternatives to the proposed activity that are feasible and reasonable.

**Significant Effect/Impact** - means an impact that by its magnitude, duration, intensity or probability of occurrence may have a notable effect on one or more aspects of the environment.

**Stakeholder Engagement** - The process of engagement between stakeholders (the proponent, authorities and IAPs) during the planning, assessment, implementation and/or management of proposals or activities. The level of stakeholder engagement varies depending on the nature of the proposal or activity as well as the level of commitment by stakeholders to the process. Stakeholder engagement can therefore be described by a spectrum or continuum of increasing levels of engagement in the decision-making process. The term is considered to be more appropriate than the term "public participation".

**Stakeholders** - A sub-group of the public whose interests may be positively or negatively affected by a proposal or activity and/or who are concerned with a proposal or activity and its consequences. The term therefore includes the proponent, authorities (both the lead authority and other authorities) and all interested and affected parties (IAPs). The principle that environmental consultants and stakeholder engagement practitioners should be independent and unbiased excludes these groups from being considered stakeholders.

**Sustainable Development** - "Development that meets the needs of the current generation without compromising the ability of future generations to meet their own needs and aspirations" – the definition of the World Commission on Environment and Development (1987). "Improving the quality of human life while living within the carrying capacity of supporting ecosystems" – the definition given in a publication called "Caring for the Earth: A Strategy for Sustainable Living" by the International Union for Conservation of Nature (IUCN), the United Nations Environment Programme and the World Wide Fund for Nature (1991).

# 1 BACKGROUND AND INTRODUCTION

Mr. Alwyn van Straten (the Proponent) appointed Geo Pollution Technologies (Pty) Ltd to undertake an environmental assessment for the existing and proposed agriculture, tourism and hospitality activities on Farm Campbellsdrei, FMM/00137, in the Hardap Region (Figure 1). The proponent currently irrigates 29.5 ha citrus orchards and 21.1 ha lucerne fields. Irrigation is from six production boreholes, by means of centre pivot and micro-irrigation systems (borehole numbers: WD 317009, WDR 180002, WDR 180004, WDR 18080012, WDR 18080013 and WDR 18080014). The proponent further proposes to develop the farm to also cater for the tourism and hospitality industry.

The proponent's objective is to produce organic citrus products for local and international markets. Agricultural practices are also conservation orientated with as little impact on the environment as possible. Agricultural activities will be supplemented by construction of guest rooms, guesthouses and a camping site and lodge. Planned activities include birding, mountain biking, hiking and game viewing. A game camp with various species is also present on the farm. An air-strip is planned to allow for small aircraft. Support infrastructure include photovoltaic panels for electricity generation and a planned consumer fuel installation.

The potential impacts of the construction, operational and possible decommissioning phases of the project on the environment were determined through the risk assessment as presented in this report. The environment being defined in the Environmental Management Act as "land, water and air; all organic and inorganic matter and living organisms as well as biological diversity; the interacting natural systems that include components referred to in sub-paragraphs, the human environment insofar as it represents archaeological, aesthetic, cultural, historic, economic, paleontological or social values".

The environmental assessment was conducted to apply for an environmental clearance certificate in compliance with Namibia's Environmental Management Act (Act No 7 of 2007) (EMA).

***Project Justification*** – The fifth National Development Plan of Namibia (NDP5) recognises the importance of both the agricultural and tourism sectors in Namibia. Currently agriculture supports approximately 70% of Namibians and provide employment to roughly a third of the workforce. Tourism provides employment to about 7% of the workforce and caters for approximately 1.5 million tourists per year. The NDP5's desired outcome, in terms of agriculture, is to see a reduction in food insecurity and an increase in food production while for tourism a competitive and diversified tourism industry is envisioned, with a growth in the number of tourists visiting Namibia (1.8 million by 2022).

Taking into consideration aspects such as climate change, desertification and the current drought, agriculture is becoming increasingly difficult. Diversifying income generating activities, to supplement each other, are thus ideal. The proponent wishes to achieve this by combining various forms of agriculture with the tourism and hospitality industry. Furthermore, the production of high value produce is ideal in order to generate more income per cubic meter of water used.

Benefits of the existing and proposed activities on Campbellsdrei include:

- Food production and enhanced food security for local and international markets,
- Increasing tourism options in the area will benefit the tourism industry of the region by providing more incentives to visit the area,
- Employment, skills and technological development,
- Generation of income contributing to the national treasury,
- Support for economic resilience in the area through diversified business activities and opportunities.

# 2 SCOPE

The scope of the environmental assessment is to:

1. Determine the potential environmental impacts emanating from the existing and proposed activities.

2. Identify a range of management actions that could mitigate the potential adverse impacts to acceptable levels.
3. Comply with the requirements of EMA.
4. Provide sufficient information to the relevant competent authority and MET to make an informed decision regarding the project.

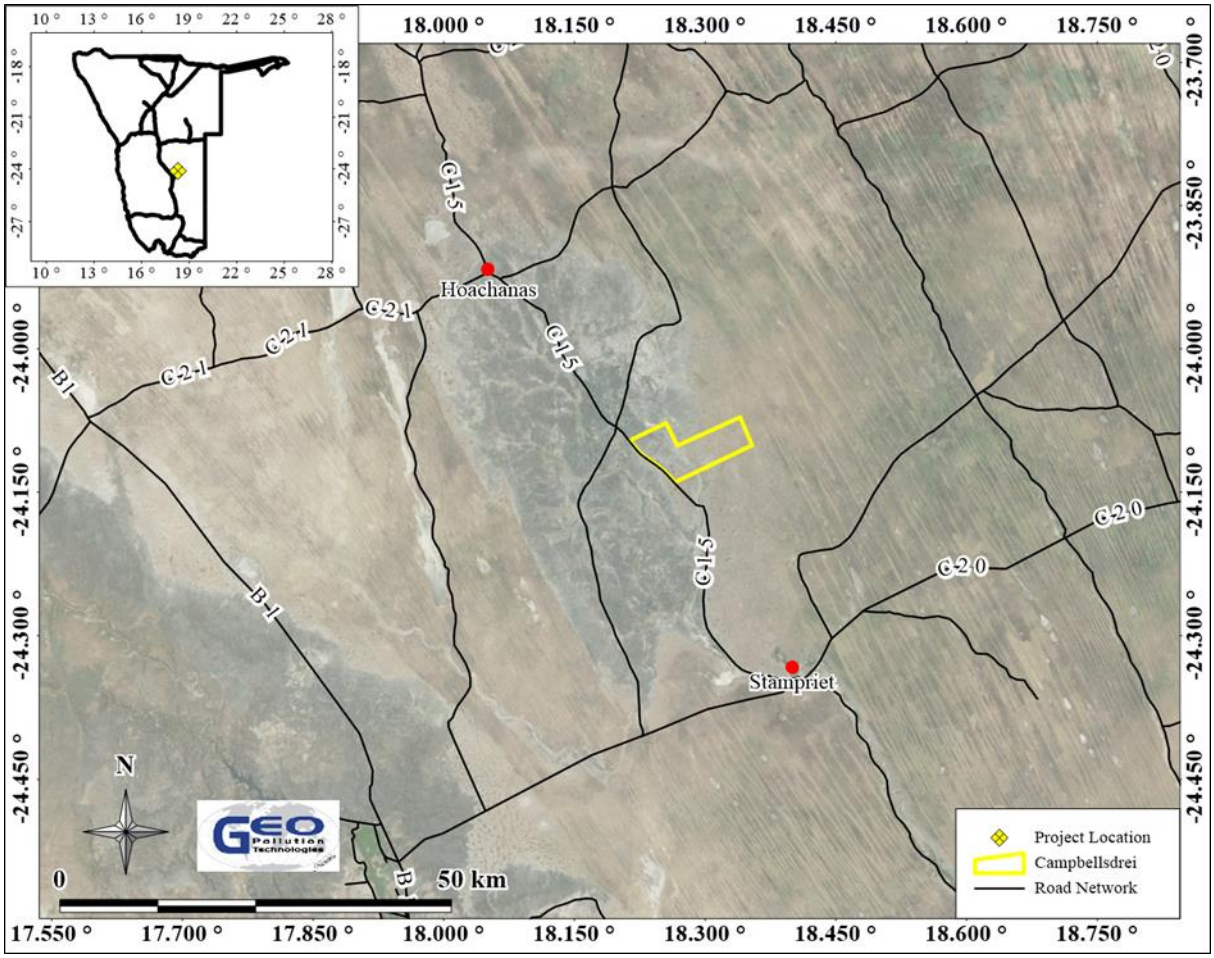



**Figure 1. Project location**

# 3 METHODOLOGY

Methods employed to investigate potential impacts on the social and natural environment due to the agricultural, hospitality and related activities on, as well as possible decommissioning of, the farm include:

1. Detailed infrastructure and operational procedures were obtained from the client and described in the report.
2. Baseline information about the site and its surroundings were obtained from primary information (hydrogeological specialist study), existing secondary information as well as from a reconnaissance site visit.
3. As part of the scoping process to determine potential environmental impacts, interested and affected parties (IAPs) were consulted about their views, comments and opinions, all of which are presented in this report.
4. Impacts were identified and preventative and mitigation measures suggested in the EMP.
5. The scoping report and EMP will be submitted to the Ministry of Environment and Tourism (MET) together with an application for an ECC.

# 4 OPERATIONS AND RELATED ACTIVITIES

## 4.1 BACKGROUND

The proponent bought Campbellsdrei in 2017. The farm was in a degraded condition with the previous owner not performing any care or maintenance on the farm. In terms of livestock and/or game farming, very little activity took place, with only few cattle present on the farm. Poaching was a big problem and the environment was considerably polluted. Only one person was employed and little to no contribution through commercial farming was made to the Namibian economy.

Since acquisition of the farm, the proponent has undertaken a major clean-up operation. Large investments were made to rehabilitate and upgrade infrastructure such as fences, roads, boreholes and buildings. The vision of the proponent is to transform the farm into a commercially productive agricultural, hospitality and hunting venture.

The following sections provide a brief description of the existing and proposed infrastructure and operations, divided between the agricultural, hospitality and hunting activities, on the farm.

## 4.2 AGRICULTURE

The farm has thirteen livestock camps with water supply from 11 boreholes. The camps have joint watering posts for livestock and game. The proponent's main interest is however the production of organic citrus for local and international markets, and not livestock farming. The main agricultural activities are concentrated near the main dwelling in two blocks – referred to as Block 1 and Block 2 for purposes of this report (Figure 2).

Irrigation is from six boreholes using both centre pivot irrigation and micro-irrigation with micro-sprayers (see sections 4.2.1 and 4.2.2 for explanations on these techniques). All citrus orchards are under micro-sprayers while lucerne fields are under centre pivot irrigation. Block 1 consists of a 9.5 ha established orange orchard (Photo 1). Block 2 has two lucerne fields of 6.5 and 14.6 ha respectively, as well as a 20 ha block cleared for lemon and orange trees (Photo 2 and Photo 4). For citrus production three to four different cultivars will be established.

The soil from all irrigated fields were analysed in order to determine its suitability for cropping and the need for fertilizers. This will be repeated on an ad hoc basis. Groundwater analysis is performed every six to eight months. The citrus orchards have soil moisture probes attached to weather stations, which indicate when the water content of the soil is depleted. The advantages of measuring soil moisture are firstly prevention of water stress on the trees by knowing when to irrigate, and secondly to save water by only irrigating when necessary.

Establishment of orchards requires land clearing and removal of most big rocks and stones. Irrigation pipes and micro-sprayers are then installed (Photo 3 and Photo 4). Holes spaced according to the trees specific requirements are made in the soil and the trees planted. For the first two to three years, trees are prevented from fruiting by pruning. This allows for all energy going into growth rather than fruit production. Once fruiting is allowed, harvesting of ripe fruits will be conducted by hand. Fruits will be packed in a packaging store (to be constructed) and transported to various markets. The proponent practices agricultural methods whereby all pruned material is left on the ground around the tree stem. Here it will decompose and enrich the soil. Also, grasses and other herbaceous plants growing in between trees are left in place. This protects the soil from the harsh sun and can be used as fodder in times of drought. A positive spinoff of from allowing natural vegetation to grow, is its potential to attract various animals like birds and bees.

All trees imported for planting are certified black spot free, a fungal disease often found on citrus fruits. It is the intention of the proponent to farm organic and as such, no pesticides will be applied to the citrus orchards.

Lucerne is established by preparing and ploughing the fields and planting lucerne seeds. Lucerne is a perennial legume that once established can be cut and baled, using tractors, up to six times a

year for about five years. After five years, the yield typically has diminished to such a degree that new lucerne needs to be established. Lucerne is planted for use as fodder for the farm's own animals, but ultimately also for sale to other farmers as feed.

**Photo 1. Orange trees with micro-sprayers and HDPE piping**

**Photo 2. Lucerne under centre pivot irrigation**

**Photo 3. Installation of pipelines and related infrastructure**

**Photo 4. Area cleared and being prepared for planting citrus trees**

### 4.2.1 Pivot-Irrigation Systems

Phocaides (2007) provides a concise description of the centre pivot irrigation system, being a low to medium pressure fully mechanised, automated irrigation system of permanent assembly. It comprise of a sprinkler pipeline (usually of high tensile galvanized light steel or aluminium pipes) supported above ground by mobile A-frame towers, long spans, steel trusses and/or cables. The pipeline is connected to a central tower with the "pivot mechanism" and main control panel. The central tower is a fixed structure with a concrete base secured at a fixed water supply point, in the centre of the pivot (field). The entire system is self-propelled to slowly rotate around the central tower while dispensing water through sprinklers (emitters) connected to the pipeline. An automatic alignment systems ensures the irrigation pipeline remains straight while a drive system enables the system movement.

Mobile towers are typically approximately 3 m in height while being spaced about 30 m apart. The spans are therefore roughly 30 m in length. The entire length of the system may vary from design to design and therefore the size of the irrigated area will also vary. Longer systems will have a greater circumference and larger range. Photo 5 depicts a typical centre pivot system, while Photo 6 and Photo 7 presents some of the pivots system's features.

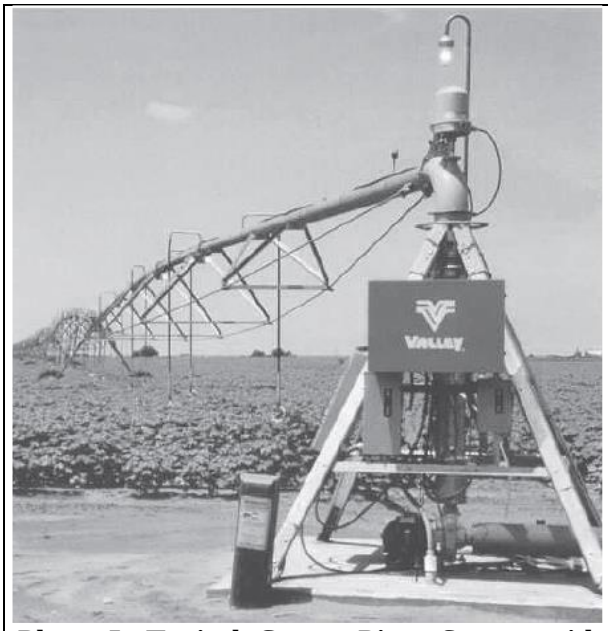


**Photo 5. Typical Centre Pivot System with Fixed Central Tower (Phocaides (2007)**

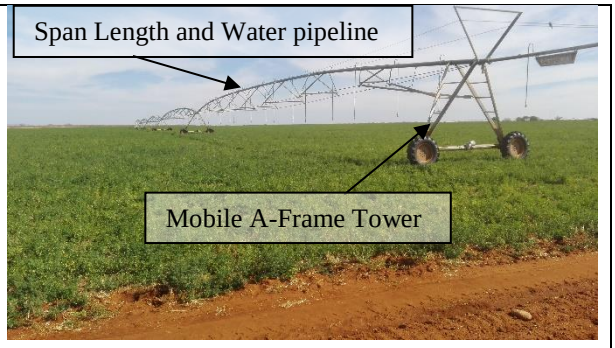



**Photo 6. Central Pivot System Pipeline**

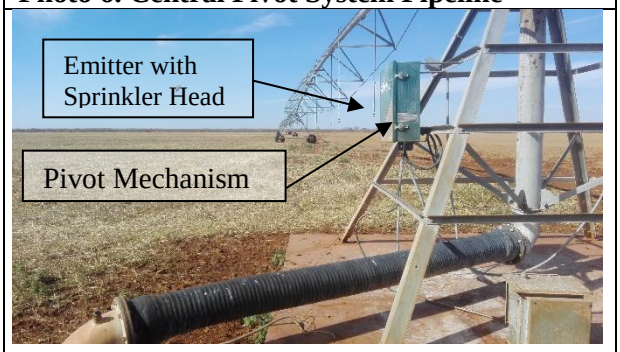



**Photo 7. Central Pivot System Employed in the Region**

### 4.2.2 Micro-sprayers

Micro-irrigation typically refers to localised irrigation by means of sprayers, drippers, bubblers or micro-jets (Phocaides 2007). Micro-sprayers are plastic emitters, typically gyro emitters, placed at the base of a plant that sprays fine droplets uniformly around the tree stem (Photo 8). They are typically installed on a plastic support or "riser", to keep it steady above the ground and is connected to aboveground or buried plastic piping (Photo 9 and Photo 4). Micro-sprayers are made of polyethylene, which is resistant to agrochemicals and weather conditions. Emitters are designed to prevent insect penetration into the nozzle.

**Photo 8. Micro-sprayer**

**Photo 9. Operational micro-sprayer**

## 4.3 HOSPITALITY SECTOR

A diverse hospitality development is planned for Campbellsdrei in order to attract a variety of tourists. Some of the existing buildings on the farm will be restored as guestrooms. A lodge / guesthouse with 10 double rooms and a restaurant is planned for the farm. The exact design and location for this have not been determined yet. It will however be typical of similar developments in Namibia and will be incorporated into the environment to have the least possible impact. A 10

stand campsite will be constructed in an area approximately 600 m south of the main farm dwelling. It will have a shared ablution block with four showers and four toilets.

Activities for guests will include hiking, cycling, game viewing and birding. A nine-hole golf course is also proposed. The golf course will incorporate the natural environment with minimal disruption of the vegetation. All surfaces will remain gravel/soil and no lawns will be established for the tee-off, fairways or greens. Therefore no water will be required for irrigation purposes.

**Photo 10. Proposed area for camping site**

**Photo 11. Watering point for game**

## 4.4 GAME AND HUNTING

The farm has a variety of game including oryx and springbok and various smaller animals like duiker, porcupine, aardvark, warthog, bat-eared fox, caracal and jackal in all existing camps. A 530 ha fenced game camp is present. The game camp accommodates animals like blue wildebeest (including golden blue wildebeest), sable, nyala, roan, waterbuck, red hartebeest, oryx and springbok (white and black).

In addition to game viewing, it is the intention of the proponent to offer responsible hunting excursions of selected species on the farm. All hunting will be performed according to the laws and legislation controlling hunting in Namibia. This include hunting seasons, permits, quantities, etc. When hunting is planned, strict control will be in place to ensure no personnel or guests are close to the hunting areas or shooting ranges.

## 4.5 WATER SUPPLY

The main water supply for the project area is groundwater. An existing groundwater abstraction permit allows for abstraction of 50,000 $m^3$ per annum (Appendix A). An earth dam, which was repaired when the farm was bought, is located in a watercourse near the main dwelling and orchards. There are 11 boreholes on the farm. Since 2017, six of the boreholes were rehabilitated according to industry standards. The remaining five boreholes will be rehabilitated over time. No additional boreholes will be drilled.

Groundwater is abstracted using solar pumps. Three of the boreholes supply water to Block 1 and three to Block 2. Having three production boreholes at each block allows for redundancy in the system, in order to prevent water shortages if one pump / borehole fails.

Potable water is supplied from the same boreholes as for irrigation and is pumped into two elevated 10,000 $m^3$ plastic tanks for storage. From here it is reticulated to all areas on the farm requiring potable water.

## 4.6 SUPPORT INFRASTRUCTURE

Operations will be enabled and supported by a variety of infrastructure on the farm. In many instances operations will not be feasible without the support infrastructure. Support infrastructure on the farm include the following:

- Power supply,
- Fuel storage,
- Waste handling, and
- Storage and maintenance area.

### 4.6.1 Power Supply

Electricity is supplied by two photovoltaic installations of 48 kW each. A 60 kVA standby generator on a trailer is available for when any power interruptions are experienced or if electricity is required at night for irrigation purposes. The latter only needed during very cold, windless conditions in winter months to prevent frost damage to young citrus trees.

### 4.6.2 Fuel Storage

A consumer fuel installation will be constructed. It will likely consist of two underground storage tanks with dispensers. The installation will comply with South African National Standards (SANS) as prescribed by the Ministry of Mines and Energy. All spill control infrastructure required will be in place, including concrete surfaces with spill catchment traps where refuelling takes place.

### 4.6.3 Solid Waste and Effluent Handling

The proponent plans to enter into an agreement with the Stampriet Village Council for disposal of general waste. If no agreement can be reached, a dedicated waste disposal area will be identified where waste can be sorted for recycling purposes, and non-recyclables burned. Any hazardous waste will be temporarily stored and then removed from the farm and disposed of at an approved hazardous waste disposal facility.

Tree cuttings and or pruned material will be left in field as cover material in the orchards. Non-hazardous biological waste will be composted while potentially hazardous biological waste (e.g. animals dying of disease) will be burnt.

Currently all effluent from the main dwelling enters a French drain while similar structures are planned for the workers' houses, ablution facilities at the orchards, and guest accommodation. The proponent is investigating the potential use of a biological waste water treatment plant(s) to treat water up to irrigation standards. Such water will be used solely for gardens and non-agricultural purposes.

**Photo 12. 48 kW Photovoltaic plant with pumphouse**

#### 4.6.4 Storage and Maintenance Area

All equipment used for agricultural purposes is kept in a roofed storage and maintenance area. Incorporated into the layout of this area will be a chemical storage area. Although operations are planned to exclude pesticide application, the chemical storage area may also be used for cleaning product storage. All fertilizers will be stored in dedicated storage areas. Additional outbuildings are present for general storage purposes and vehicle parking.

### 4.7 EMPLOYMENT

The proponent employs 14 permanent employees and up to 14 seasonal employees. Workers enter into employment contracts with the proponent and are registered with social security. All workers are semi-skilled and have one or more vocational skill. These include skills such as welding, brick and cement work for building, tractor or back actor operator, etc. With expansion of agricultural activities and development of the hospitality operations, a significantly larger employee base will be established.

Between 10 and 12 worker houses are planned to accommodate the current workforce. Worker accommodation will include running water with solar geysers and flush toilets. A hall will be built for worker entertainment purposes while a small soccer pitch is also planned for workers near their accommodation.

### 4.8 GENERAL

Fire breaks are maintained on the farm and firefighting equipment is present. The proponent intends to obtain a mobile firefighter.

An air-strip for small fixed wing aircraft is planned and the area was already cleared. It will be 1,000 m long and 40 m wide. It will be constructed according to the regulations and requirements of the Namibia Civil Aviation Authority. Small volumes of aviation gasoline (avgas) may be stored for refuelling purposes.

A health and safety plan is in place on the farm and will be updated and expanded on as operations continue (Appendix A). If citrus exports to international markets realise, additional plans and policies will be developed to comply with the requirements of clients.

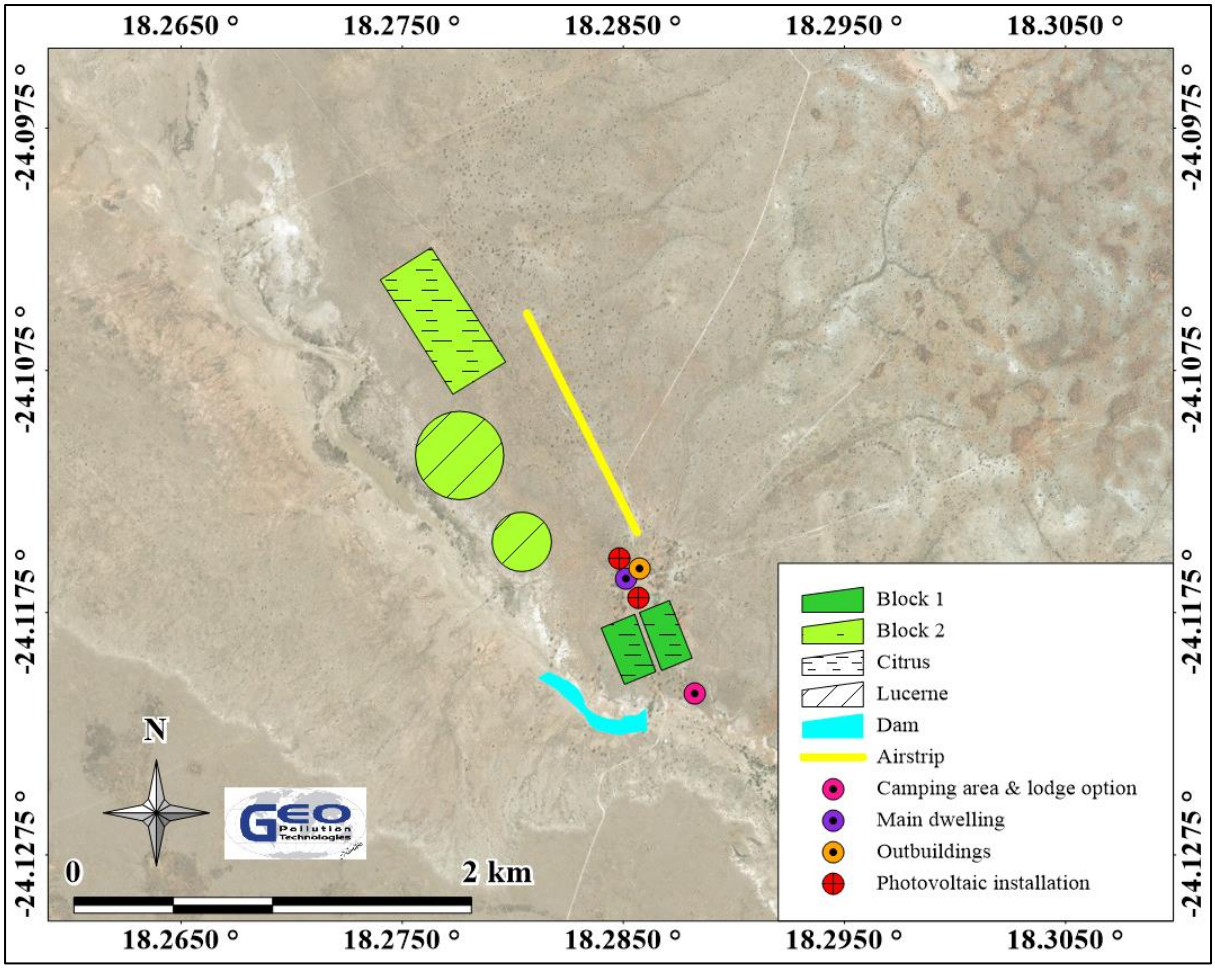



**Figure 2. Farm layout**

# 5 ALTERNATIVES

## 5.1 PROJECT IMPLEMENTATION AND DESIGN ALTERNATIVES

Campbellsdrei is in the initial phases of being developed. Alternatives were and are continually considered to optimise the development of the farm and its operations. Alternatives relate to land use, crop choice, cultivation and irrigation methods, hospitality options and related infrastructure. There are no viable surface water resources to consider. Therefore, there are no alternative water sources for the existing irrigation operations.

### 5.1.1 Irrigation Methods

When choosing irrigations systems, the most viable irrigation option is not only based on the irrigation system's design efficiency, but also environmental constraints and operating costs. Some systems are simply not viable due to climatic and topographical features as well as cost implications. For example, flood irrigation is not viable on steeper gradients, is more expensive to produce if water needs pumping, and is less efficient in terms of water consumption. The considered irrigation system should therefore take into account the local water source and topographical and climatic conditions.

The type of produce cultivated also plays a determining factor. Highly efficient yet expensive irrigation systems (such as drip irrigation) only becomes feasible for high-income crops. In turn, some crops will not produce high yields when cultivated under less efficient systems. Table 1 depicts different types of irrigation systems as per the South African Irrigation Institute's suggested efficiencies (IWRM Plan Joint Venture Namibia, 2010). The estimated average costs are based on 35 ha units. Although flood systems are not viable irrigation

methods, these have been included for comparison with regard to capital cost and design efficiency. Table 2 compares the alternatives considered on Farm Campbellsdrei.

**Table 1. Irrigation system efficiency (IWRM Plan Joint Venture Namibia, 2010)**

| Irrigation System | Design Efficiency | Capital Costs (N$ / ha) |
|---|---|---|
| **Flood: Furrow** | 65% | 13,000 |
| **Flood: Border** | 60% | 17,600 |
| **Flood: Basin** | 75% | 18,800 |
| **Sprinkler: Dragline** | 75% | 24,800 |
| **Sprinkler: Quick-coupling** | 75% | 22,500 |
| **Sprinkler: Permanent** | 85% | 34,500 |
| **Sprinkler: Travelling boom** | 80% | 23,200 |
| **Sprinkler: Centre pivot** | 85% | 43,300 |
| **Sprinkler: Linear** | 85% | 69,400 |
| **Sprinkler: Micro-sprinkler** | 85% | 36,300 |
| **Micro: Spray** | 90% | 53,200 |
| **Micro: Drip** | 95% | 46,300 |

**Table 2. Alternatives considered on Farm Campbellsdrei**

| Alternative | Advantages | Disadvantages | Preferred Option |
|---|---|---|---|
| **Type of land use** | | | |
| **Agriculture** | ♦ Contribute to national food security and feed for the livestock sector<br>♦ Potential export markets and foreign income | ♦ Reliant on availability of water and grazing thus additional stress on groundwater and potential for food shortages for animals during droughts. | ♦ Combination of agriculture, hospitality and conservation based tourism and hunting increases resilience |
| **Commercial or industrial development** | ♦ Water availability support industry<br>♦ Potential production of high value commodities | ♦ Far away from suppliers and markets<br>♦ Industry does not fit in with the landscape character<br>♦ Potential for pollution of environment and specifically groundwater is high | |
| **Conservation** | ♦ Protection of biodiversity and groundwater | ♦ Reduced income in the agricultural sector | |
| **Hunting** | ♦ High value commodity for | ♦ Hunting is perceived as | |

| | | | |
|---|---|---|---|
| | professional hunters<br>♦ Management of game to allow for sustainable hunting serves a conservation purpose | negative by some<br>♦ Poaching of wildlife stocks | |
| **Hospitality** | ♦ Important revenue generation sector in Namibia that is promoted by government<br>♦ Diversification of the hospitality options in the area may attract more tourists, also benefiting other tourist establishments and local businesses | ♦ Increased traffic in the area may cause deterioration of roads | |
| **Choice in agricultural produce** | | | |
| **Livestock – sheep or goats** | ♦ Southern Namibia is better suited for sheep and goat farming | ♦ Typically many losses due to vermin like jackals | ♦ Combination of various agricultural methods ensure resilience to external factors like drought, fluctuating markets, etc. |
| **Livestock - cattle** | ♦ Less predatory losses | ♦ Area less suitable for cattle farming | |
| **Horticulture** | ♦ Possibility of high value crop production<br>♦ Situated on a groundwater resource favourable for irrigation | ♦ Potential groundwater impacts in the form of over abstraction or pollution | |
| **Irrigation method** | | | |
| **Sprinkler** | ♦ Cheaper infrastructure options available than for micro-irrigation<br>♦ Robust infrastructure available | ♦ Less water efficient than micro-irrigation<br>♦ Some systems requires more labour input and thus additional costs | **Citrus:** Micro-sprayers due to water efficiency and ability to combat frost<br>**Lucerne:**<br>Centre pivot sprinkler system which is less expensive and more robust |
| **Micro-sprayers** | ♦ Can be used to prevent frost<br>♦ Cover a larger area for crops with root | ♦ Expensive infrastructure<br>♦ Can be easily damaged when | |

| | | | |
|---|---|---|---|
| | systems extending laterally<br>♦ Good water efficiency | installed aboveground<br>♦ Sprayers can get blocked if water contains larger particles | |
| **Drip irrigation** | ♦ Highly water efficient<br>♦ Very localized irrigation prevent weed growth away from the target crop | ♦ Expensive infrastructure<br>♦ Can be easily damaged when installed aboveground<br>♦ Drippers can get blocked if water contains larger particles | |
| **Effluent Disposal** | | | |
| **Conventional effluent treatment (septic tank, French drain, evaporation ponds)** | ♦ Cheaper technology<br>♦ Quick to install and maintain | ♦ Final effluent not suitable for irrigation purposes and can still pose pollution potential | ♦ In a dry country like Namibia a biological waste water treatment plants are preferred where significant volumes of waste water is produced (e.g. tourist accommodation establishments) and groundwater is vulnerable. |
| **Biological waste water treatment plant** | ♦ Very effective treatment<br>♦ Water can be re-used for selected irrigation purposes | ♦ Very expensive technology<br>♦ Requires specially skilled persons for servicing and repairs | |

### 5.2 NO GO ALTERNATIVE

Until 2017, Campbellsdrei contributed very little, if not nothing, towards employment and revenue generation in Namibia. The farm will continue to be unproductive, should the proponent not receive environmental clearance. There would be a significant loss in capital investment and revenue generation potential for Namibia. The biophysical attributes of the area allows for horticulture which is not viable in large portions of Namibia. Not allowing the project may see the land utilised for significantly less profitable operations.

# 6 ADMINISTRATIVE, LEGAL AND POLICY REQUIREMENTS

All projects, plans, programmes and policies with potential adverse impacts on the environment require an environmental assessment, as per the Namibian legislation. This promotes protection of the environment as well as sustainable development. The legislation and standards provided in Table 3 to Table 5 govern the environmental assessment process in Namibia, and are relevant to the assessed development.

**Table 3. Namibian law applicable to the development**

| Law | Key Aspects |
|---|---|
| **The Namibian Constitution** | ♦ Promote the welfare of people<br>♦ Incorporates a high level of environmental protection<br>♦ Incorporates international agreements as part of Namibian law |

| Law | Key Aspects |
|---|---|
| **Environmental Management Act**<br>Act No. 7 of 2007, Government Notice No. 232 of 2007 | ♦ Defines the environment<br>♦ Promotes sustainable management of the environment and the use of natural resources<br>♦ Provides a process of assessment and control of activities with possible significant effects on the environment |
| **Environmental Management Act Regulations**<br>Government Notice No. 28-30 of 2012 | ♦ Commencement of the Environmental Management Act<br>♦ List activities that requires an environmental clearance certificate<br>♦ Provide Environmental Impact Assessment Regulations |
| **Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act**<br>Act No. 36 of 1947; Government Notice No. 1239 of 1947 | ♦ Governs the registration, importation, sale and use of fertilizers, farm feeds, agricultural remedies and stock remedies<br>♦ Various amendments and regulations |
| **Seed and Seed Varieties Act 23 of 2018**<br>Act No. 23 of 2018, Government Notice No. 368 of 2018 | ♦ Provides for restrictions on the importation of seed<br>♦ Not in force yet |
| **The Water Act**<br>Act No. 54 of 1956 | ♦ Remains in force until the new Water Resources Management Act comes into force<br>♦ Defines the interests of the state in protecting water resources<br>♦ Controls water abstraction and the disposal of effluent<br>♦ Numerous amendments |
| **Water Resources Management Act**<br>Act No. 11 of 2013 | ♦ Provides for management, protection, development, use and conservation of water resources<br>♦ Prevention of water pollution and assignment of liability<br>♦ Not in force yet |
| **Forest Act**<br>(Act 12 of 2001, Government Notice No. 248 of 2001) | ♦ Makes provision for the protection of the environment and the control and management of forest fires<br>♦ Provides for the licencing and permit conditions for the removal of woody and other vegetation as well as the disturbance and removal of soil from forested areas. |
| **Forest Regulations: Forest Act, 2001**<br>Government Notice No. 170 of 2015 | ♦ Declares protected trees or plants<br>♦ Issuing of permits to remove protected tree and plant species. |
| **Soil Conservation Act**<br>Act No. 76 of 1969 | ♦ Law relating to the combating and prevention of soil erosion, the conservation, improvement and manner of use of the soil and vegetation and the protection of the water sources in Namibia |

| Law | Key Aspects |
|---|---|
| **Biosafety Act**<br>Act No. 7 of 2006 | ♦ Regulate activities involving the research, development, production, marketing, transport, application and other uses of genetically modified organisms and specified products derived from genetically modified organisms<br>♦ Prohibits planting of genetically modified organisms without registration |
| **Petroleum Products and Energy Act**<br>Act No. 13 of 1990, Government Notice No. 45 of 1990 | ♦ Regulates petroleum industry<br>♦ Makes provision for impact assessment<br>♦ Petroleum Products Regulations (Government Notice No. 155 of 2000)<br>♦ Prescribes South African National Standards (SANS) or equivalents for construction, operation and decommissioning of petroleum facilities (refer to Government Notice No. 21 of 2002) |
| **Local Authorities Act**<br>Act No. 23 of 1992, Government Notice No. 116 of 1992 | ♦ Defines the powers, duties and functions of local authority councils |
| **Public Health Act**<br>Act No. 36 of 1919 | ♦ Provides for the protection of health of all people |
| **Public and Environmental Health Act**<br>Act No. 1 of 2015, Government Notice No. 86 of 2015 | ♦ Provides a framework for a structured more uniform public and environmental health system, and for incidental matters<br>♦ Deals with integrated waste management including waste collection disposal and recycling, waste generation and storage, and sanitation |
| **Labour Act**<br>Act No 11 of 2007, Government Notice No. 236 of 2007 | ♦ Provides for Labour Law and the protection and safety of employees<br>♦ Labour Act, 1992: Regulations relating to the health and safety of employees at work (Government Notice No. 156 of 1997) |
| **Atmospheric Pollution Prevention Ordinance**<br>Ordinance No. 11 of 1976 | ♦ Governs the control of noxious or offensive gases<br>♦ Prohibits scheduled process without a registration certificate in a controlled area<br>♦ Requires best practical means for preventing or reducing the escape into the atmosphere of noxious or offensive gases produced by the scheduled process |
| **Hazardous Substances Ordinance**<br>Ordinance No. 14 of 1974 | ♦ Applies to the manufacture, sale, use, disposal and dumping of hazardous substances as well as their import and export<br>♦ Aims to prevent hazardous substances from causing injury, ill-health or the death of human beings |
| **Pollution Control and Waste Management Bill (draft document)** | ♦ Not in force yet<br>♦ Provides for prevention and control of pollution and waste<br>♦ Provides for procedures to be followed for licence applications |

**Table 4. Relevant multilateral environmental agreements**

| Agreement | Key Aspects |
|---|---|
| **Stockholm Declaration on the Human Environment, Stockholm 1972.** | ♦ Recognizes the need for a common outlook and common principles to inspire and guide the people of the world in the preservation and enhancement of the human environment |
| **United Nations Framework Convention on Climate Change (UNFCCC)** | ♦ The Convention recognises that developing countries should be accorded appropriate assistance to enable them to fulfil the terms of the Convention |
| **Convention on Biological Diversity, Rio de Janeiro, 1992** | ♦ Under article 14 of The Convention, EIAs must be conducted for projects that may negatively affect biological diversity |
| **International Treaty on Plant Genetic Resources for Food and Agriculture, 2001** | ♦ Promote conservation, exploration, collection, characterization, evaluation and documentation of plant genetic resources for food and agriculture<br>♦ Promote the sustainable use of plant genetic resources for food and agriculture |

**Table 5. Standards or codes of practise**

| Standard or Code | Key Aspects |
|---|---|
| **GLOBALG.A.P.** | ♦ Farm assurance program, translating consumer requirements into good agricultural practice. |
| **South African National Standards (SANS)** | ♦ The Petroleum Products and Energy Act prescribes SANS standards for the construction, operations and demolition of petroleum facilities.<br>♦ SANS 10089-3:2010 is specifically aimed at storage and distribution of petroleum products at fuel retail facilities and consumer installations.<br>o Provide requirements for spill control infrastructure |

The agricultural and related activities listed as activities requiring an environmental clearance certificate are (Government Notice No. 29 of 2012):

4. Forest Activities

- 4.The clearance of forest areas, deforestation, afforestation, timber harvesting or any other related activity that requires authorisation in terms of the Forest Act, 2001 (Act No. 12 of 2001) or any other law (Some additional clearing of bush /timber may be required for the establishment of the lodge, camp sites, related infrastructure).

7. Agriculture and Aquaculture Activities

- 7.5 Pest control (Although the proponent plans the organic approach to citrus production, some pest control may be required for other activities on the farm. Any pesticide considered will be from the list approved by the Ministry of Agriculture)

8. Water Resource Developments

- 8.1 The abstraction of ground or surface water for industrial or commercial purposes. (Abstraction of groundwater for the commercial production of crops.)
- 8.6 Construction of industrial and domestic wastewater treatment plants and related pipeline systems. (French drains for domestic use and a wastewater treatment plant will be required for the tourism accommodation.)
- 8.7 Irrigation schemes for agriculture excluding domestic irrigation. (No *irrigation scheme* will be developed, however, *irrigation systems* are used on the farm. Irrigation on the farm does not contribute to /or is part of any irrigation scheme as proclaimed by the Namibian Government.)

9. Hazardous Substance Treatment, Handling and Storage

- 9.1 The manufacturing, storage, handling or processing of a hazardous substance defined in the Hazardous Substances Ordinance, 1974. (Planned consumer fuel installation.)
- 9.2 Any process or activity which requires a permit, licence or other form of authorisation, or the modification of or changes to existing facilities for any process or activity which requires an amendment of an existing permit, licence or authorisation or which requires a new permit, licence or authorisation in terms of a law governing the generation or release of emissions, pollution, effluent or waste. (Planned consumer fuel installation.)
- 9.3 Construction of filling stations or any other facility for the underground and aboveground storage of dangerous goods, including petrol, diesel, liquid petroleum gas or paraffin. (Planned consumer fuel installation.)

10. Infrastructure

- 10.1(d) Airports and airfields (Planned construction of an airfield)

11. Other Activities

- 11.2 Construction of cemeteries, camping, leisure and recreation sites (Planned camping site)

# 7 ENVIRONMENTAL CHARACTERISTICS

This section lists pertinent environmental characteristics of the study area and provides a statement on the potential environmental impacts on each.

## 7.1 LOCALITY AND SURROUNDING LAND USE

Campbellsdrei FMM/00137 (24.116 °S; 18.285 °E) is located approximately 26 km north of Stampriet, along the C15 main road (road number M0033) leading to Hoachanas. All adjacent properties are farms and land use thus consists of agriculture. The adjacent farms and owners are listed in Table 6 and indicated in Figure 3.

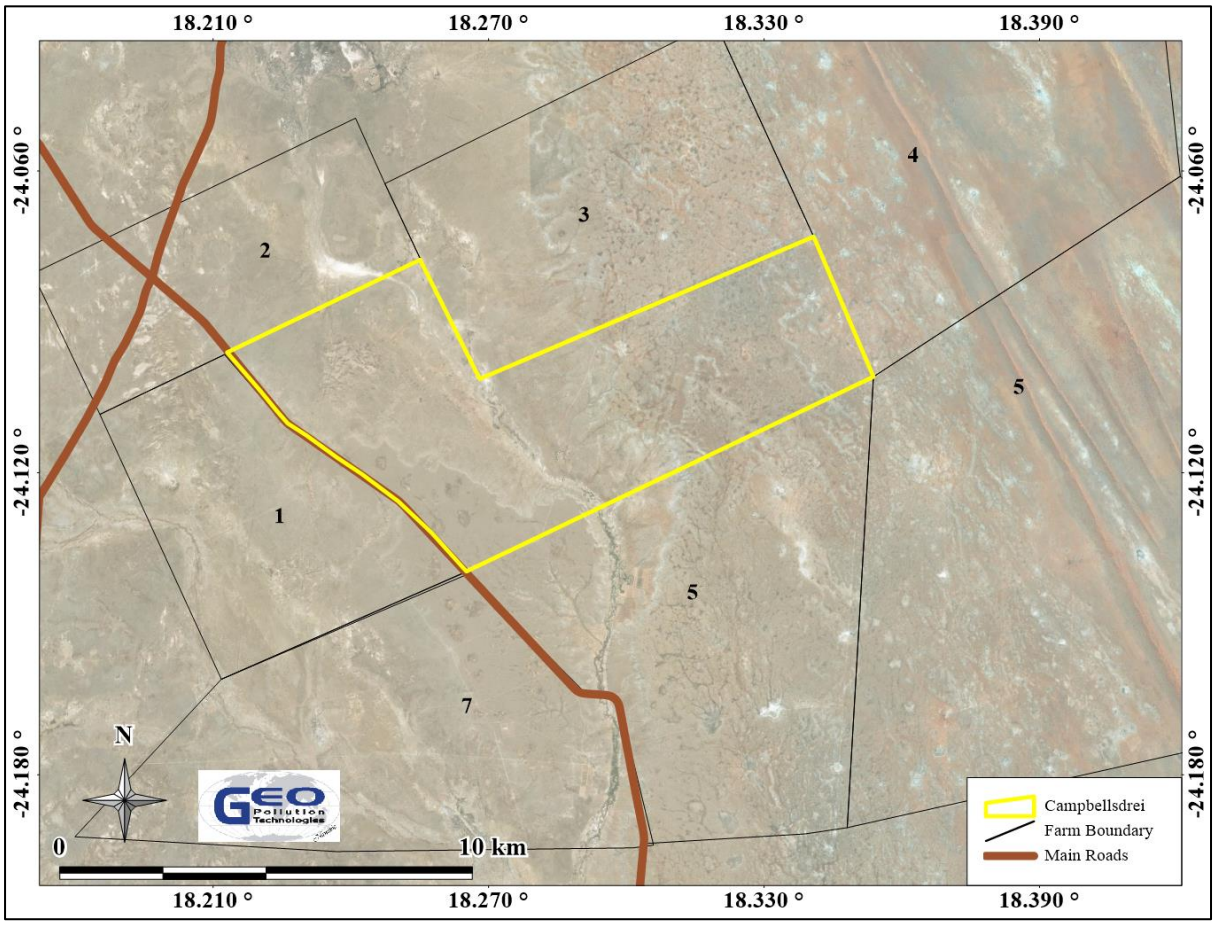



**Figure 3. Properties adjacent to the project area**

**Table 6. Adjacent farms**

| Number on Map | Direction from Campbellsdrei | Farm Name and Owner |
|---|---|---|
| 1, 2 & 3 | West and north | Lidfontein - Daniel Frey |
| 4 | Northeast | Olivia – Freddie Oosthuizen |
| 5 | Southeast | Koms – Anton Zondach |
| 6 & 7 | South and southwest | Galenbeck – Jean Roux |

***Implications and Impacts***

The location is well suited for the agricultural activities, tourism and hospitality due to the characteristics of the surrounding environment, current land use and availability of groundwater. The farm is surrounded by properties with activities of similar nature.

## 7.2 CLIMATE

Campbellsdrei is situated in a hot desert climate. Days are mostly warm, but very hot during the summer months. Nights are generally cooler, but very cold in the winter with sub-zero temperatures often recorded. Rainfall events are mostly sporadic and of short duration, but higher intensity. Soft continuous rain is a rare occurrence. Rainfall typically occurs from October to April, but the highest rainfall is normally received during the months of January, February and March, whilst July and August are generally dry. The average annual rainfall in the area is low, with very high variability and evaporation. These factors contribute to it being a relatively harsh climate. Table 7 below contain a summary of climate conditions for the area.

Namibia is vulnerable to climate change and is expected to be significantly impacted. Temperatures is predicted to increase and rainfall is expected to become more variable. A spatial shift in agricultural potential of land is likely, with southern Namibia, typically suitable for small stock farming, becoming unsuitable for commercial farming. Suitable smalls stock farming land will shift northeast, decreasing the available area for large stock farming. Large farms in southern Namibia will struggle to survive financially if relying only on farming.

**Table 7. Summary climate data**

| | |
|---|---|
| **Precipitation** | 200 – 250 |
| **Variation in annual rainfall (%)** | 50-60% |
| **Average annual evaporation (mm/a)** | 3,200 – 3,400 |
| **Water deficit (mm/a)** | 2,100 – 2,300 |
| **Temperature (°C)** | 19 - 20 |

| Average Monthly Rainfall (mm) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** |
| **0.3** | **0.8** | **1.7** | **8.5** | **12.0** | **15.7** | **43.4** | **51.8** | **39.7** | **20.9** | **3.9** | **1.8** |

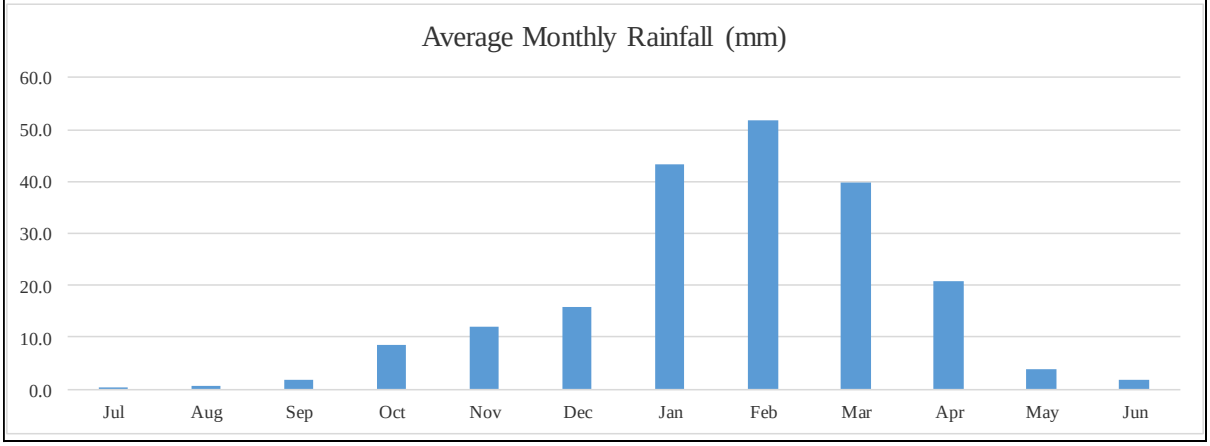



**Figure 4. Average monthly rainfall for the area (Atlas of Namibia)**

***Implications and Impacts***

Water is a scarce and valuable resource in Namibia. Thunderstorms with heavy rainfall that can occur in short periods of time (cloud bursts) occur in the area and can cause damage to crops and infrastructure. Heavy rainfall can lead to soil erosion where ground cover is removed or excavations are made.

Climate change will negatively impact the farming sector in Namibia, and especially southern Namibia.

## 7.3 TOPOGRAPHY AND DRAINAGE

The general topography of the Stampriet Artesian aquifers catchment can be described as relatively flat, with the elevation decreasing towards the southeast. The project area forms part of the Kalahari sandveld landscape The Kalahari sandveld is known for palaeo dunes and pans, which can be clearly seen in the larger study area. The farm is located on the flat area surrounding the Auob River with dunes located to the east and west of the farm. All the dunes in the area are parallel and strike north of northwest to east of southeast.

Drainage is poorly developed in the area. The site falls within the catchment of the Auob River, an ephemeral river, draining in a southern direction.

***Implications and Impacts***

The lack of major surface runoff and drainage may lead to ponding and even flooding of plains during heavy rainfall events. This may negatively impact soil quality, due to mineral leaching from the soil, and subsequent crop production.

## 7.4 SOIL

The soils of the Kalahari Group can be classified as petric Calcisols for the large area of the farm with only a small portion in the northeastern coner comprising of eutric Leptosols (Figure 5). A Calcisol can be described as soil containing substantial secondary accumulation of lime that can vary in depth. These soils are common in arid and semi-arid environments and also in areas with a high calcareous parent geology. A petrocalcic horizon (petric) is a subsurface horizon which form when secondary carbonates, like calcium and others, accumulate in the subsoil to the extent that the soil becomes cemented. Leptosols can be described as very shallow soils over hard rock or normally calcareous rocks or deep soils containing a lot of stones and gravel. A eutric horizon can be described as having, at least between 20 cm to 100 cm from the soil surface, or in a layer 5 cm thick directly above a lithic contact in Leptosols and have a base saturation of 50 % or more. Figure 5 depict the surface geology as sand and calcrete.

***Implications and Impacts***

Agricultural activities are concentrated on areas with soil more suitable to cropping. Improper farming techniques may result in soil losing its cropping potential by becoming nutrient poor or brackish.

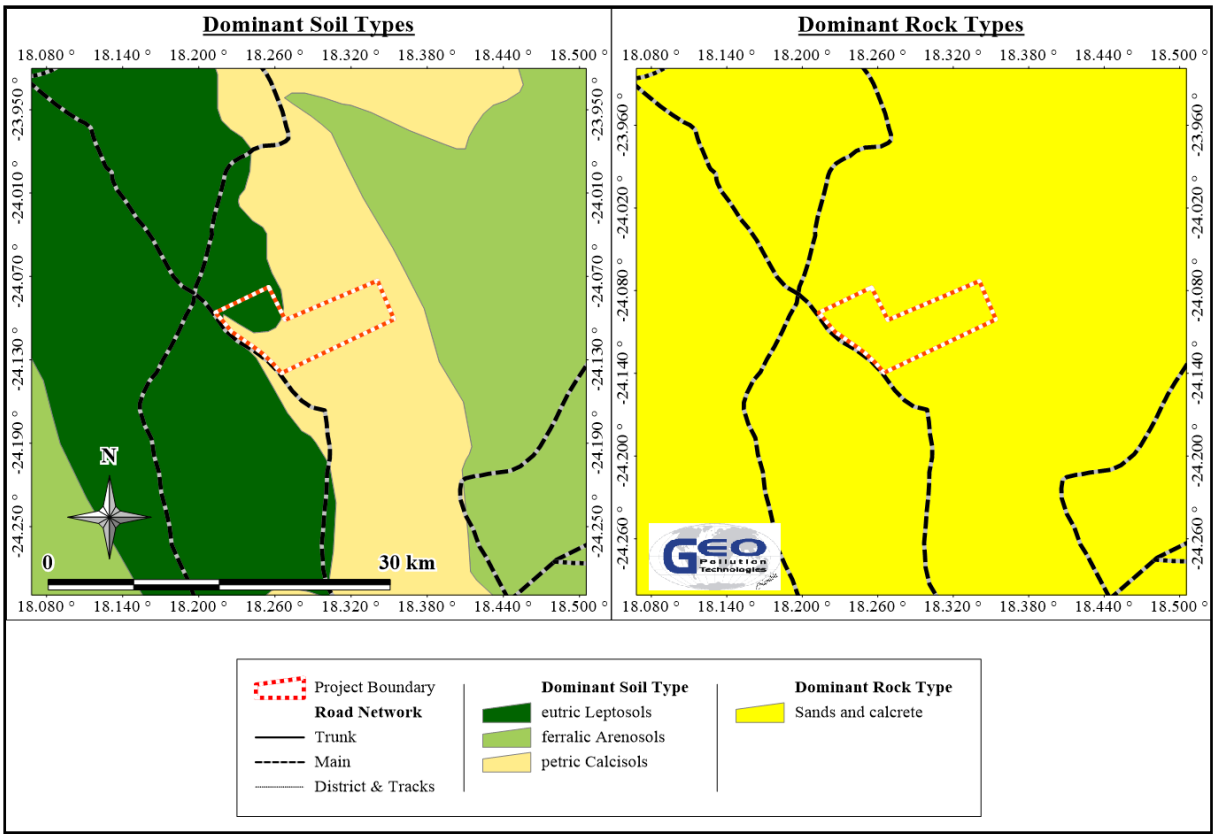



**Figure 5. Dominant soil and rock types**

## 7.5 GEOLOGY AND HYDROGEOLOGY

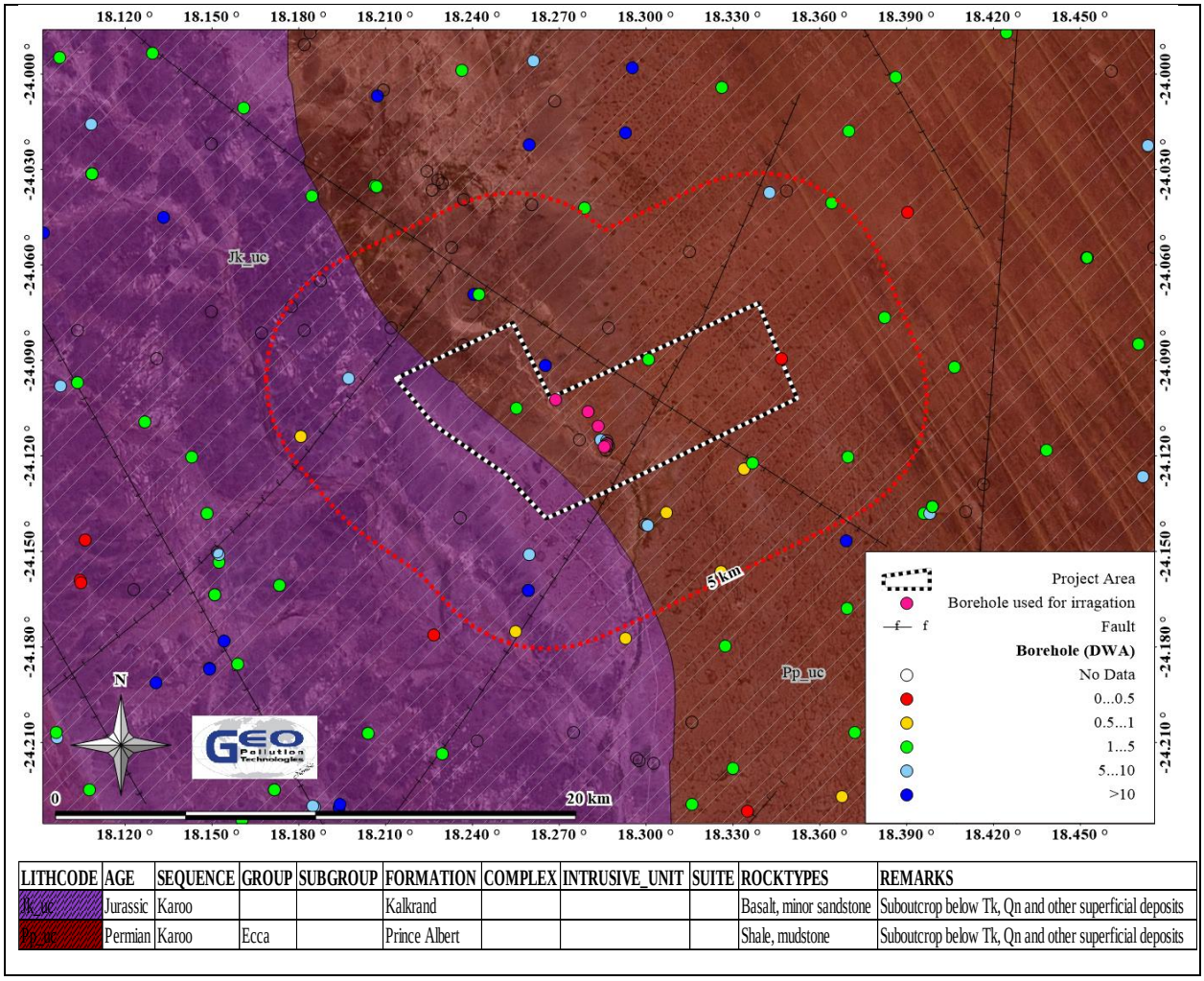
A hydrogeological map can be seen in Figure 6 below. The basement rocks of the Stampriet artesian aquifer consists of the Damara Sequence, the Nama Group and the Dwyka Group.

The geology of the Nama Group consist of layered sedimentary rocks mostly sandstone and shale which formed during the Cambrian age in a marine environment. The Dwyka Group forms part of the Karoo Sequence and was formed during the late Permian and early Carboniferous Age and consists of complex successions of tillite, glaciomarine mudstones with dropstones and minor glaciofluvial sandstones, all formed in a glacier environment.

The 2 major aquifer layers are the Auob and Nossob Member of the Prince Albert Formation forming part of the Ecca Group of the Karoo Sequence. Both these two Members consist of sedimentary rocks mostly just sandstones with the Auob Member also containing layers of coal.

The surficial geology on site consist of soil forming part of the Kalahari group which were deposited since the start of the Cenozoic era (66 Ma) up until today. The Subsurface geology on the larger portion of the farm consist of shale and mudstone of the Prince Albert Formation. The Prince Albert Formation formed during the Permian Age and forms part of the Ecca Group in the Karoo Sequence. A small portion along the western border of the farm consist of basalt and minor sandstone of the Kalkrand Formation. This formation also formed during the Karoo Sequence but formed during the younger Jurassic Age (Figure 6). The figure also depict the boreholes used for the irrigation on the farm, as well is boreholes captured in the DWA database with their yields.

For more detail on the geology refer to the hydrogeology specialist study conducted for this project (Appendix B).




| LITHCODE | AGE | SEQUENCE | GROUP | SUBGROUP | FORMATION | COMPLEX | INTRUSIVE_UNIT | SUITE | ROCKTYPES | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|
| Jk_uc | Jurassic | Karoo | | | Kalkrand | | | | Basalt, minor sandstone | Suboutcrop below Tk, Qn and other superficial deposits |
| Pp_uc | Permian | Karoo | Ecca | | Prince Albert | | | | Shale, mudstone | Suboutcrop below Tk, Qn and other superficial deposits |

**Figure 6. Hydrogeological map**

**Table 8. Groundwater Statistics**

| Query Centre: | Campbellsdrei; -24.1158°S; 18.2809°E | | | | | | | | | Query Box Radius: 5.0km | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | NUMBER OF KNOWN BOREHOLES | LATITUDE | LONGITUDE | DEPTH (mbs) | YIELD (m3/h) | WATER LEVEL (mbs) | WATER STRIKE (mbs) | TDS (ppm) | SULPHATE (ppm) | NITRATE (ppm) | FLUORIDE (ppm) |
| Data points | 18 | | | 10 | 8 | 10 | 1 | 4 | 4 | 4 | 4 |
| Minimum | | -24.070804 | 18.231601 | 31 | 1 | 0 | 27 | 506 | 18 | 11 | 0 |
| Average | | | | 78 | 9 | 6 | 27 | 541 | 27 | 22 | 0 |
| Maximum | | -24.160796 | 18.330199 | 197 | 40 | 20 | 27 | 620 | 46 | 50 | 1 |
| Group A | | | | 20.00% | 12.50% | 80.00% | 0.00% | 100.00% | 100.00% | 0.00% | 100.00% |
| *Limit* | | | | 50 | >10 | 10 | 10 | 1000 | 200 | 10 | 1.5 |
| Group B | | | | 60.00% | 37.50% | 20.00% | 100.00% | 0.00% | 0.00% | 75.00% | 0.00% |
| *Limit* | | | | 100 | >5 | 50 | 50 | 1500 | 600 | 20 | 2.0 |
| Group C | | | | 20.00% | 50.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| *Limit* | | | | 200 | >0.5 | 100 | 100 | 2000 | 1200 | 40 | 3.0 |
| Group D | | | | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 25.00% | 0.00% |
| *Limit* | | | | >200 | <0.5 | >100 | >100 | >2000 | >1200 | >40 | >3 |

*Statistical grouping of parameters is for ease of interpretation, except for the grouping used for sulphate, nitrate and fluoride, which follow the Namibian guidelines for the evaluation of drinking-water quality for human consumption, with regard to chemical, physical and bacteriological quality. In this case the groupings has the following meaning: Group A: Water with an excellent quality, Group B: Water with acceptable quality, Group C: Water with low health risk, Group D: Water with a high health risk, or water unsuitable for human consumption.*

Groundwater flow is expected to take place through primary porosity in the surface cover, while it is expected to flow along fractures, faults, dykes/mineralised faults or along contact zones (secondary porosity) and other geological structures present within the underlying formations (hard rock

formations). Table 8 indicates the groundwater statistics for a radius of 5 km around the project area (Figure 6). The groundwater information was obtained from Department of Water Affairs (DWA) borehole database and from the proponent. The DWA database is generally outdated and more boreholes might be present. Groundwater is widely utilised in the study area, with a total of 18 boreholes within a 5 km radius. The boreholes are drilled to an average depth of 78 m below surface and yield between 1 and 40 m³/h.

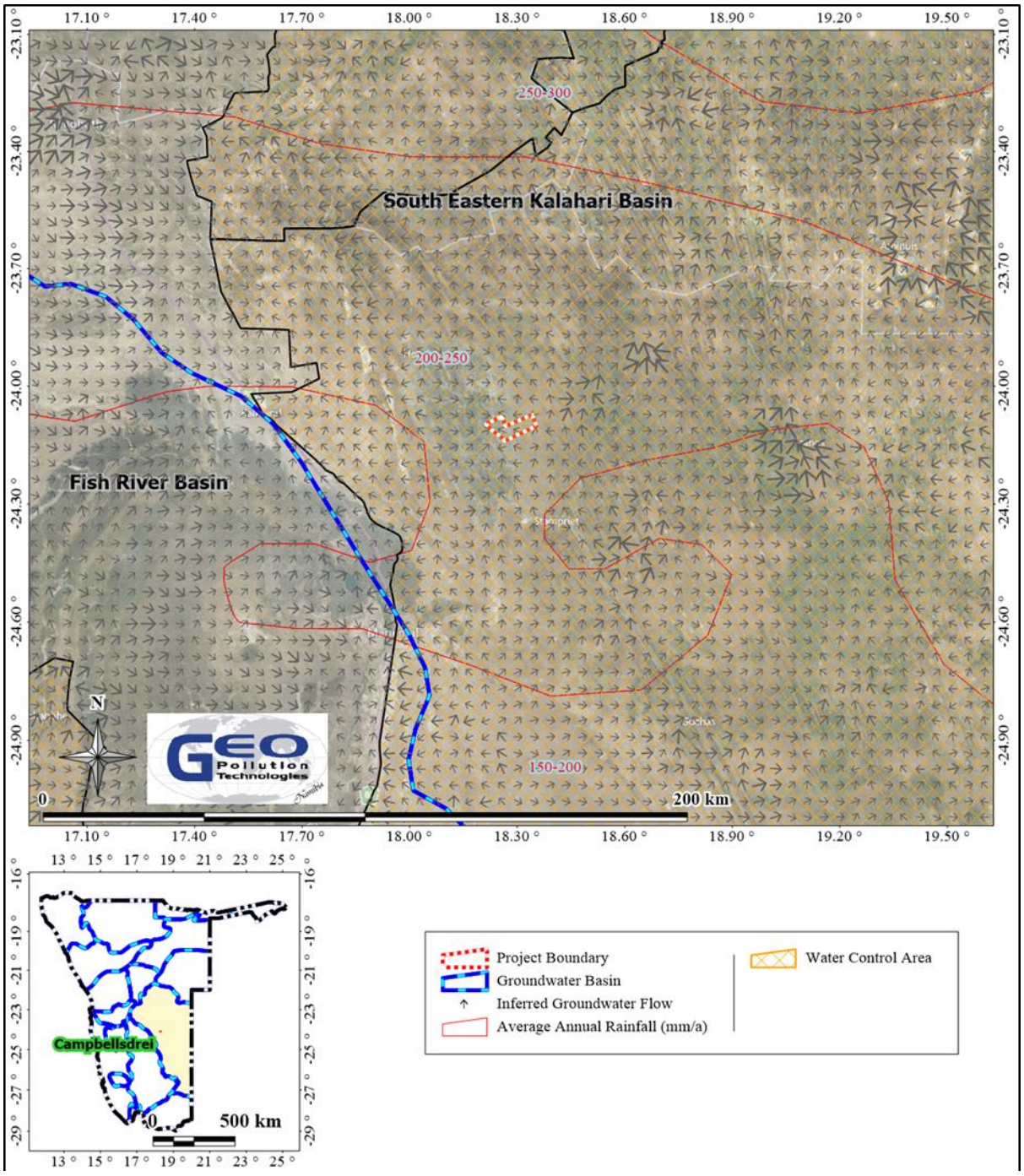



**Figure 7. Groundwater basin with rainfall and inferred groundwater flow**

According to the Ministry of Agriculture, Water and Forestry (MAWF, 2006) the farm is located inside the Windhoek-Gobabis-Mariental-Keetmanshoop Artesian Area - Government Notice 302 of 1 October 1955. Government regulates groundwater usage in this area and all other groundwater related activities like drilling, cleaning or deepening of boreholes and rates of water abstraction. See Figure 7 for a map indicating the water control area, groundwater basin and

inferred groundwater flow. The site is located within the South Eastern Kalahari Groundwater Basin. Groundwater flow on site can be expected in a north-western direction.

Groundwater quality data is presented in Figure 8 as a Maucha Plot. From the figure it is clear that the groundwater of the project location is mostly of a calcium-magnesium-bicarbonate water type which suggest the water is recently recharged and typical type of water for a calcrete rich environment.

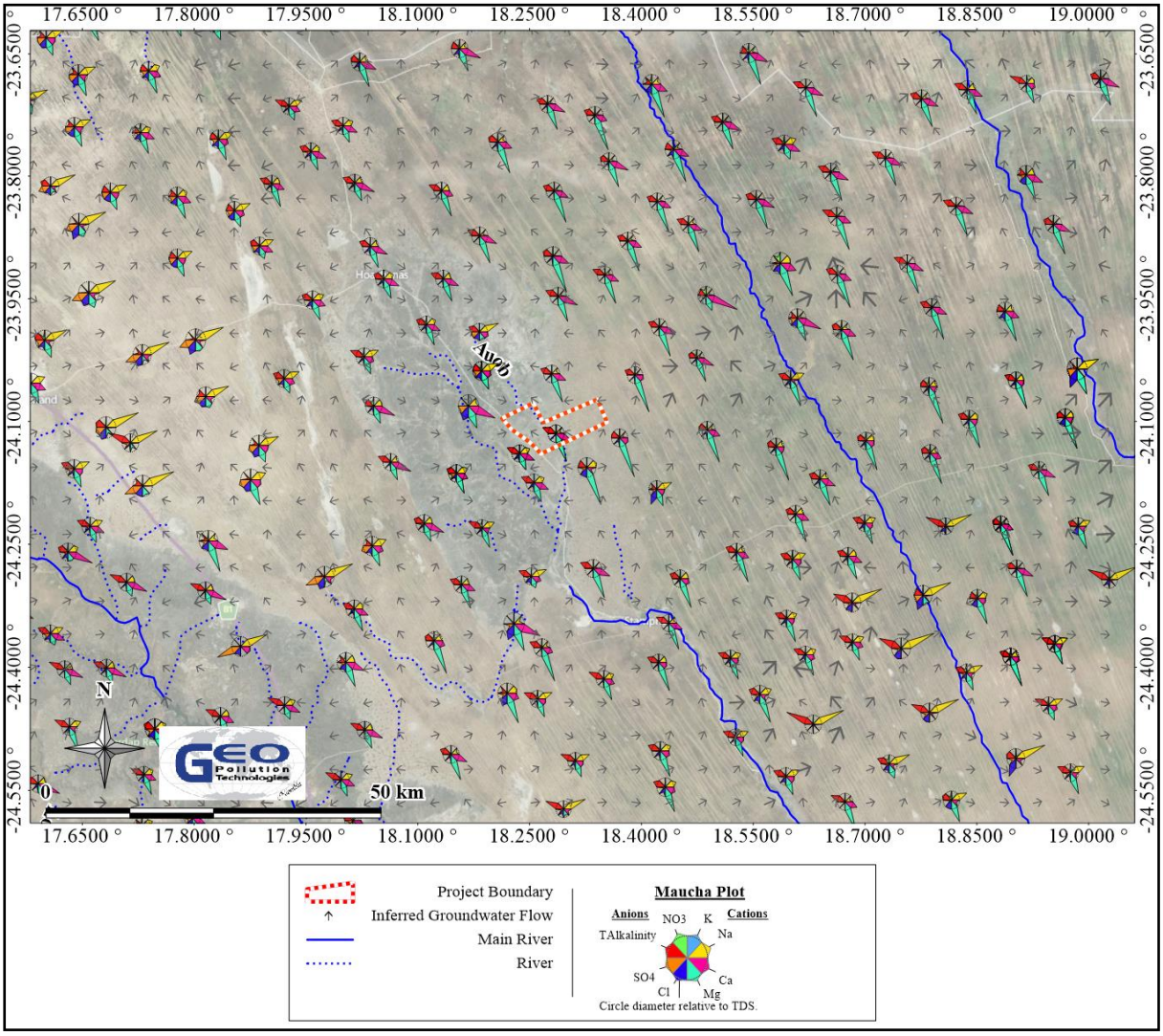



**Figure 8. Groundwater quality**

***Implications and Impacts***

A risk to groundwater pollution is expected due to the geological sensitivity of the area. Groundwater is utilized in the area and such users would be at risk if groundwater contamination occurs. Irresponsible irrigation methods like over-irrigation may result in higher demands for fertiliser, herbicides and pesticides, which in turn will increase nitrates, herbicide and pesticide concentration in the groundwater.

Over abstraction may also impact on other users of the aquifer.

## 7.6 PUBLIC WATER SUPPLY

The only available potable water supply in the area is groundwater. All farms in the immediate vicinity of Campbellsdrei thus rely on groundwater for domestic supply, irrigation and livestock watering.

***Implications and Impacts***

Groundwater is a valuable resource in the area. Groundwater contamination may negatively impact surrounding boreholes, widely utilised for public water supply. No alternative water supply options exist if extensive contamination or deterioration of groundwater occur.

## 7.7 AGRO ECOLOGICAL ZONE

The farm is situated within the Kal2-9 agro-ecological zone (AEZ) with an average growing period of 15 days. The Kal2-9 AEZ is ranked 9th in Namibia in terms of agricultural potential and is deemed only suitable for sheep farming. However, the groundwater resource allows for extended growing periods and thus makes crop production possible.

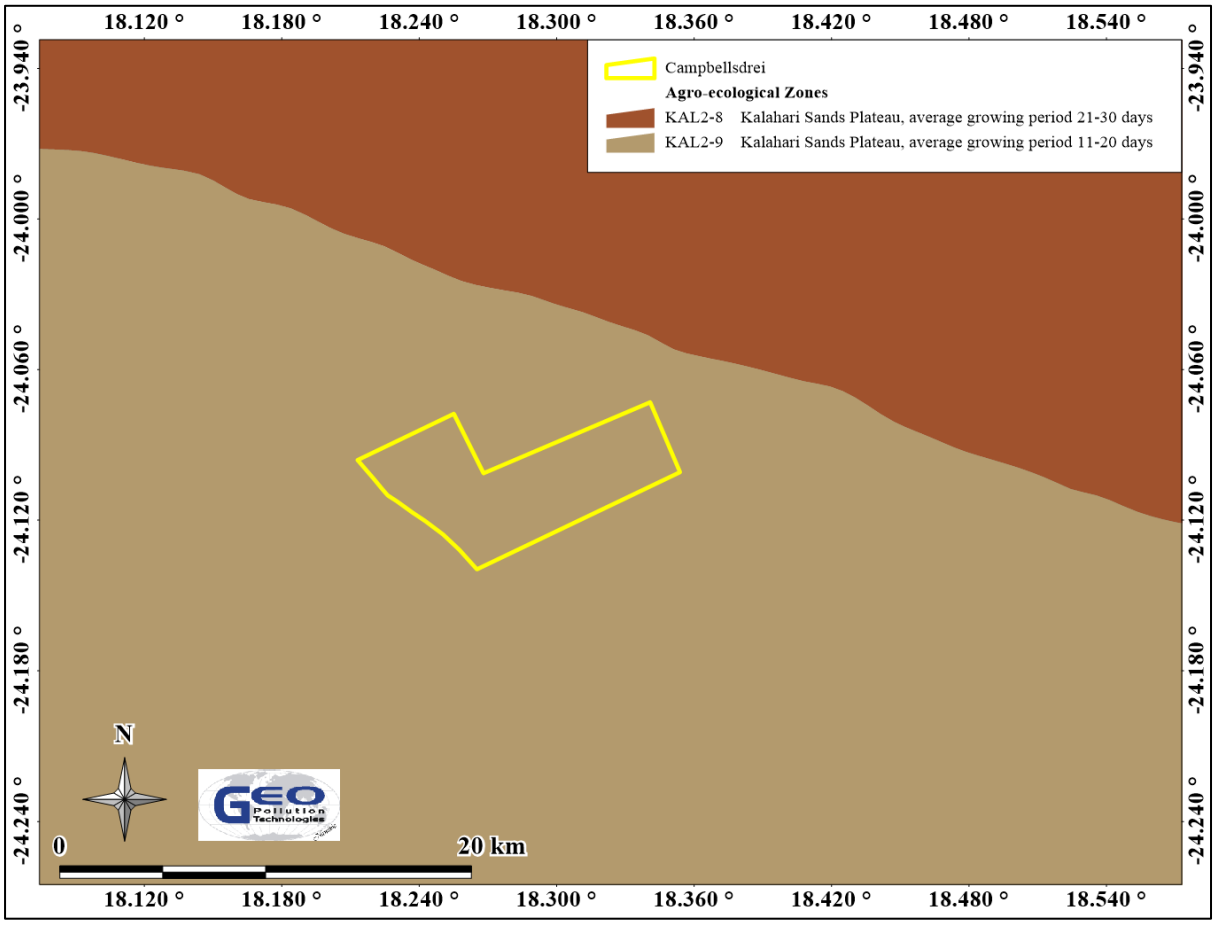



**Figure 9. Agro ecological zone**

***Implications and Impacts***

Irrigation attempts outside of suitable areas may be less productive than alternatives agricultural options such as livestock farming. This may lead to debushing and habitat destruction that ultimately may lead to desertification, if farming on this land is ceased due to unproductivity.

## 7.8 ECOLOGY

The farm is situated in the Savanna Biome and has a Southern Kalahari vegetation type with a Kalahari Shrubland structure (Atlas of Namibia). Namibia's biodiversity pattern is characterised by low species diversity, but high endemism, in the west and southwest of the country, while high species diversity, but low levels of endemism, is present towards the northeast. Towards the east and southeast low species diversity and low endemism is expected. Plant and animal diversity in the Campbellsdrei area are therefore expected to be relatively low with very low endemism.

Plant diversity is expected to be in the vicinity of 50 to 100 species, the second lowest diversity category for Namibia. Grasses like *Aristida meridionalis, Schmidtia kalahariensis* and *Eragrostis lehmanniana* dominate the Southern Kalahari. Trees such as *Acacia erioloba*, *Acacia haematoxylon* and herbaceous plants like *Grewia flava* are also characteristic of this vegetation type although very sparsely distributed. Animal diversity is also lower in the area with the most abundant vertebrates being birds. Table 9 and Table 10 present a summary of the general plant and animal diversity of the broader area. The farm's location in relation to levels of endemism is presented in Figure 9.

Campbellsdrei spans two quarter degree squares (QDS), namely 2418AA and 2418AB. According to the Tree Atlas Project, 16 different tree species occur in these quarter degrees (Curtis & Mannheimer 2005). Tree names, abundance and conservation concerns are presented in Table 11. Not all the trees listed are necessarily expected to occur on the farm. Field observations during the site visit confirmed the abundance of the water-thorn, *Acacia nebrownii*, but also indicated that the Shepherd's Tree (*Boscia albitrunca*) is abundant, which is in contradiction with the information in Table 11. The Shepherd's tree is a very valuable tree as it is an evergreen tree and many animals browse on its leaves and twigs.

Prosopis trees (*Prosopis* spp.) were introduced in southern Africa and Namibia when their pods were imported to provide food for livestock. Prosopis is a fast grower that spreads along water courses and ephemeral rivers as well as at animal watering points. Their success is as a result of their hardy seeds that survives the digestion process, and since it is a favourable food for animals, get dispersed rapidly and widely. In many areas in southern Africa they have become invasive and areas with dense stands include the Auob River near Gochas, the Hardap Scheme area near Mariental, and along the Orange River. Typical of farms in the area, Prosopis has also been introduced on Campellsdrei where they are mostly associated with animal watering points.

Typical of the larger mammals in the area are springbok and oryx that occur on the farm. However, other large mammals present or introduced to the game camp include golden and blue wildebeest, sable, nyala, black and white springbok, roan, waterbuck and red hartebeest. Various species of small mammals (duiker, porcupine, aardvark, warthog, bat-eared fox, springhare, caracal and jackal), reptiles (various snakes and lizards) and other animal taxa are present. Birds that may be encountered on the farm include the Black-chested Snake-eagle, Lappet-faced vulture, black-shouldered kite, Kori bustard, Ludwig's bustard, Northern black korhaan and various swifts, doves, cuckoos, sparrows, etc. Of the birds, the Kori bustard (*Ardeotis kori*) is classified as near-threatened while both the Ludwig's bustard (*Neotis ludwigii*) and Lappet-faced vulture (*Torgos tracheliotes*) are endangered according to IUCN criteria. All three have declining population sizes and both the bustard's have restricted ranges with the Ludwig's bustard endemic to southern Africa (Namibia, South Africa and very small areas of southern Angola and Botswana).

**Table 9. General plant data of the Southern Kalahari (Digital Atlas of Namibia)**

| | |
|---|---|
| **Biome** | Savanna |
| **Vegetation type** | Southern Kalahari |
| **Vegetation structure type** | Kalahari Shrubland |
| **Diversity of higher plants** | High (Diversity rank = 6 [1 to 7 representing highest to lowest diversity]) |
| **Number of plant species** | 50 – 100 |
| **Percentage tree cover** | 0.5 – 1 |
| **Tree height (m)** | 4 – 8 |
| **Percentage shrub cover** | 1.5 |
| **Shrub height (m)** | 2 – 4 |
| **Percentage dwarf shrub cover** | 0.3 |

| | |
|---|---|
| **Dwarf shrub height (m)** | 0.8 |
| **Percentage grass cover** | 24 |
| **Grass height (m)** | 0.8 |
| **Dominant plant species** | *Aristida meridionalis, Schmidtia kalahariensis, Eragrostis lehmanniana, Acacia erioloba, Stipagrostis uniplumis v. uniplumis, Grewia flava, Aristida stipitata s. spicata, Acacia haematoxylon* |

**Table 10. General animal data of the larger area (Digital Atlas of Namibia)**

| | |
|---|---|
| **Mammal Diversity** | 61 - 75 Species |
| **Rodent Diversity** | 16 - 19 Species |
| **Bird Diversity** | 111-140 Species |
| **Reptile Diversity** | 51 - 60 Species |
| **Snake Diversity** | 20 - 24 Species |
| **Lizard Diversity** | 28 - 31 Species |
| **Frog Diversity** | 4 - 7 Species |
| **Termite Diversity** | 7 - 9 Genera |
| **Scorpion Diversity** | 10 - 11 Species |

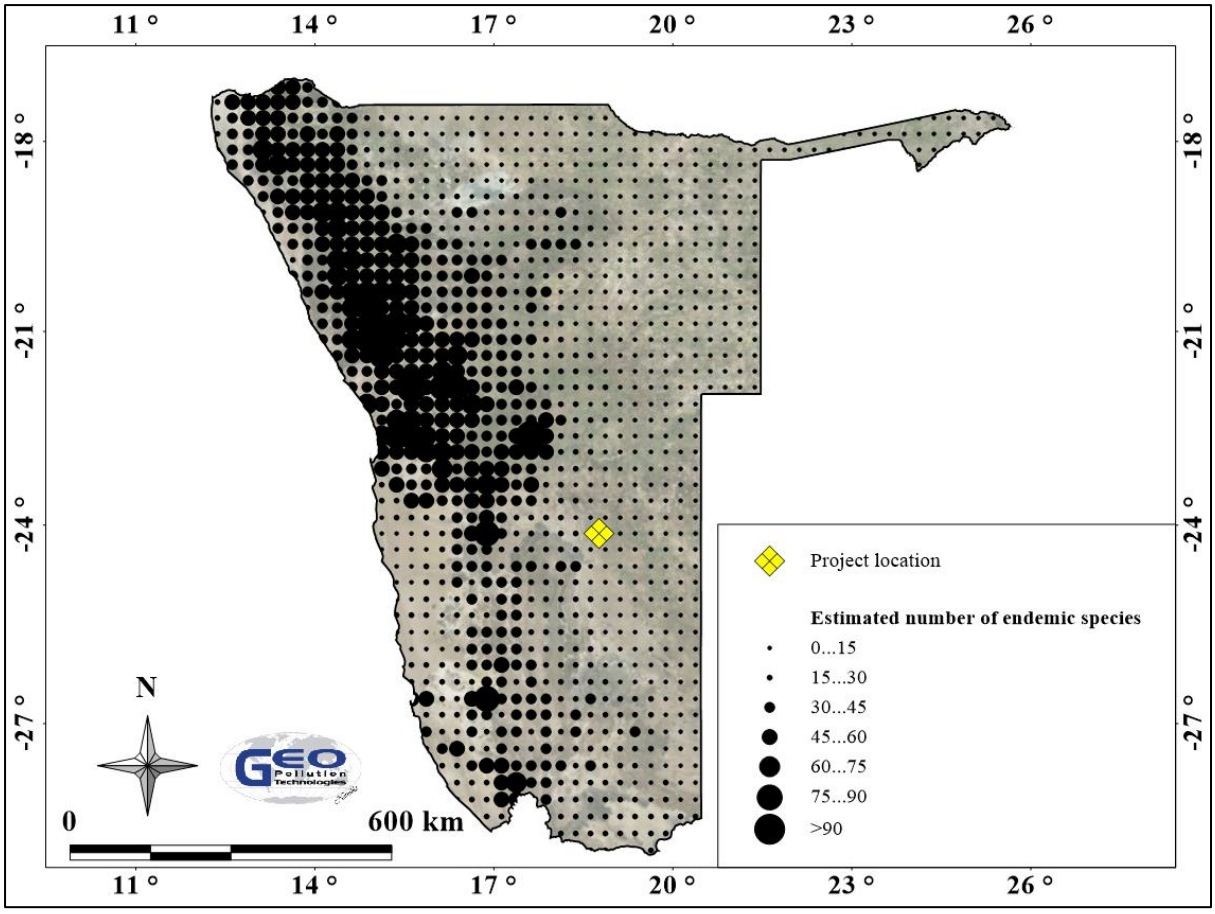



**Figure 9. Estimated endemism in Namibia**

**Table 11. Trees within quarter degree squares 2418AA and 2418AB (Curtis & Mannheimer 2005)**

| Scientific Name | Common Name | Abundance | Conservation Concerns |
|---|---|---|---|
| *Acacia erioloba* | Camel-thorn | Common to Abundant | Protected by Forestry Legislation |
| *Acacia mellifera* subsp *detinens* | Blue-thorn Acacia | Occasional | Aggressive Invasive |
| *Acacia nebrownii* | Water-thorn | Common to Abundant | |
| *Acacia tortilis* subsp *heteracantha* | Umbrella-thorn | Uncommon to Rare | |
| *Albizia anthelmintica* | Worm-cure Albizia; Aru | Occasional | Protected by Forestry Legislation |
| *Boscia albitrunca* | Shepherd's Tree | Uncommon to Rare | Protected by Forestry Legislation |
| *Boscia foetida* subsp *foetida* | Smelly Shepherd's-bush | Occasional | |
| *Catophractes alexandri* | Trumpet-thorn; Rattlepod | Common to Abundant | Invasive in some areas |
| *Commiphora pyracanthoides* | Fire Thorn Corkwood;Small Common Corkwood | Uncommon to Rare | |
| *Lycium bosciifolium* | Limpopo Honey-thorn | Uncommon to Rare | |
| *Parkinsonia africana* | Green-hair Tree | Common to Abundant | |
| *Phaeoptilum spinosum* | Brittle-thorn | Occasional | |
| *Prosopis* spp | Prosopis | Common to Abundant | |
| *Rhigozum trichotomum* | Three-thorn Rhigozum | Common to Abundant | |
| *Ziziphus mucronata* | Buffalo-thorn | Uncommon to Rare | Protected by Forestry Legislation |
| *Zygophyllum suffruticosum* | | Common to Abundant | |

***Implications and Impacts***

Agricultural activities on Cambellsdrei are established and limited additional land clearing is required. Some habitat disturbance (land clearing) is expected for the airfield, lodge and campsite and additional fields, but this is limited in size. The status quo on poaching and illegal collection of plant and animal material is a vast improvement on what it was prior to 2017. The same is true for waste pollution which was cleaned and now prohibited by the proponent.

With crop production, pollution of the soil and groundwater by hazardous chemicals and / or the excessive use of fertilizers and pesticides that may negatively impact the local ecology, is possible. The proponent however aims to produce organic crops that will prohibit the use of various chemicals.

Over-abstraction of groundwater may lead to ecosystem changes as groundwater levels decrease. Deep rooted terrestrial plants that dependent on groundwater, may dry out and eventually die.

## 7.9 DEMOGRAPHIC AND ECONOMIC CHARACTERISTICS

The project area is located in the Hardap Region with a population of 79,507 and a density of approximately 0.7 people per $km^2$ (Namibia Statistics Agency, 2012). Table 12 provides demographic information for the Mariental Rural Constituency, the Hardap Region and nationally. The population of the Hardap Region is approximately 3% more literate than the national average, but unemployment is slightly higher at 35%. In 2001, 9% of households' main source of income was from farming (Namibia Statistics Agency 2011). This has decreased to 7% in 2011.

Economic activities in the Hardap Region relates mainly to farming and tourism. The Hardap Irrigation Scheme at Mariental and the Stampriet area mainly produce crops while livestock farming is practiced in the majority of the region. At Hardap a piggery and a number of dairies are present, including Hardap Superfarm, the biggest dairy in Namibia. At the time of compiling this report, Namibia was experiencing a serious drought and the Hardap Dam supplying the Hardap Irrigation Scheme stood at approximately 10.5% of its capacity. Restrictions on irrigation were implemented and will have major economic impacts. Similarly, are the livestock industry impacted with grazing mostly depleted in large areas.

Tourism sustains some of the farms and businesses with lodges and other hospitality businesses profiting from Namibia's continued success as tourism destination. Near Campbellsdrei establishments like Kalahari Farmhouse, Bagatelle, Intu Africa and Anib Lodge are very popular.

**Table 12. Demographic characteristics of the Mariental Rural Constituency, the Hardap Region and Nationally (Namibia Statistics Agency, 2011)**

| | Mariental Rural Constituency | Hardap Region | Namibia |
|---|---|---|---|
| **Population (Males)** | 7,800 | 40,572 | 1,021,912 |
| **Population (Females)** | 7,300 | 38,935 | 1,091,165 |
| **Population (Total)** | 15,100 | 79,507 | 2,113,077 |
| **Unemployment (15+ years)** | Not Available | 35% | 33.8% |
| **Literacy (15+ years)** | Not Available | 90.9% | 87.7% |

***Implications and Impacts***

Campbellsdrei contributes to employment and livelihoods in difficult economic times. Being a new and upcoming development, income is not yet generated and it will be another two to three years before any harvesting of citrus produce will realise. However, the vision of the proponent, to combine agriculture and various forms of tourism and sustainable hunting, is a proactive approach to ensure resilience in the face of nationwide economic hardship and the potential future impacts of climate change.

## 7.10 CULTURAL, HERITAGE AND ARCHAEOLOGICAL ASPECTS

Various objects dating back to the early to middle 20th century have been found on the farm during clean-up and waste removal (Photo 13). The old homestead, buildings and discovered objects were photographed by the proponent for record keeping purposes. The farm has no living cultural museums or area of interest neither were any graves discovered on the farm.

**Photo 13. Old artefacts found on farm**

***Implications and Impacts***

Some objects of historical significance may be unearthed by the proponent.

# 8 PUBLIC CONSULTATION

Consultation with the public forms an integral component of an environmental assessment investigation. It enables Interested and Affected Parties (IAPs) e.g. neighbouring landowners, local authorities, environmental groups, civic associations and communities, to comment on the potential environmental impacts associated with a project. This aid in identification of additional impacts or concerns, which should be addressed in the environmental assessment.

The public consultation process followed the procedures as stipulated in the regulations of the EMA. Public participation notices were advertised once a week for two weeks in two national newspapers: The Republikein and the Namibian Sun on 16 and 23 September 2019. A site notice was placed on site and notification letters were hand delivered to neighbours and authorities or e-mailed where personal deliveries were not possible / preferred. See Appendix C for proof of the public participation processes and the registered IAPs. Comments were received from two of the neighbours and from the Stampriet Farmers Union. These, with responses, are attached in Appendix D

# 9 MAJOR IDENTIFIED IMPACTS

A number of potential environmental impacts were identified during the environmental scoping exercise. The following section provides a brief description of the most important of these impacts.

## 9.1 CHANGE IN LAND USE AND EARNING POTENTIAL

Change in land utilisation and related economic productivity have been altered dramatically by the current and proposed operations. The run-down state of the farm has been improved to the point of being a viable economic production unit, activating revenue generation and improving the earning potential of the farm.

## 9.2 SOCIO-ECONOMIC IMPACTS

Long term permanent employment of a skilled workforce is envisaged by the proponent. Diversification of revenue flow of the proposed operations increases the viability of the farm, as well as the related continued employment of labourers. Economic resilience of the employees are increased while contributions to the local, reginal and national treasury will be realised. No

market related revenue generation was enabled prior to the project implementation. Sector based contributions are foreseen. This include the hunting, tourism and agricultural sectors.

## 9.3 SURFACE WATER CONTAINMENT

If the earth dam on the farm is not maintained according to the requirements of the Ministry of Agriculture, Water and Forestry, the wall may be eroded away during flash floods. This may result in breaking of the wall and subsequent downstream flooding. While conducting the EIA, very good rains were received all over Namibia. This resulted in the earth dam filling up and the impounded water reached much further upstream than anticipated. The Proponent is currently in the process of lowering the overflow of the dam to reduce its overall footprint and limit it to nearby the homestead and planned tourism facilities. Once the overflow is lowered sufficiently, the risk of downstream flooding will mostly be negated. No irrigation water is abstracted from the earth dam.

## 9.4 SOIL AND GROUNDWATER CONTAMINATION

Soil and groundwater contamination are possible when large quantities of fertilizers or pesticides are applied. Excessive fertilizer use may result in increased soil nutrient levels (i.e. nitrogen, phosphorus and potassium), to a point that soil is regarded as contaminated. Similarly, pesticides can accumulate in soil at levels detrimental to biota.

## 9.5 GROUNDWATER ABSTRACTION

Groundwater abstraction is a very sensitive topic in a dry country where the value of land is drastically reduced if no or unusable groundwater is present on the land. Abstraction of groundwater must be conducted in a sensible way to prevent impacts on other groundwater users that depend on such groundwater. This includes water abstracted for human and animal use, irrigation, and also ecosystems that depend on groundwater. A typical groundwater balance was compiled to illustrate the potential consequences of over abstraction of groundwater, see Figure 10. Recharge in the area is considered to be very low. In a typical groundwater environment, a water balance would consist of inflow and outflow of the groundwater system. Over time an equilibrium (or steady state) is normally reached with rising water tables following good recharge events and declining water tables when recharge is below average.

Inflow into the system would typically be from infiltration following rainfall in the area and in upstream areas. The inflow component will further be enhanced by the high secondary porosity nature of the karst aquifer.

Outflow would be comprised of water leaving the system through springs and as outflow over the lower boundary of the groundwater system, as well as evapotranspiration losses. Groundwater abstraction through boreholes is important as this is normally necessary to sustain human and animal demands where such users became essentially dependant on the abstracted groundwater as a reliable and sustainable source.

Typical consequences of over abstraction will include a lowering in the water table. This may lead to the drying up of boreholes and springs. Vegetation will be impacted where such vegetation has access to groundwater.

Based on current water level fluctuations in the area, as presented in the specialist hydrogeology report, a short term threshold of 10 m below the long term average water level of each borehole is set from where abstraction rates should be reduced. Note that this level refers to rest water levels and not pump water levels.

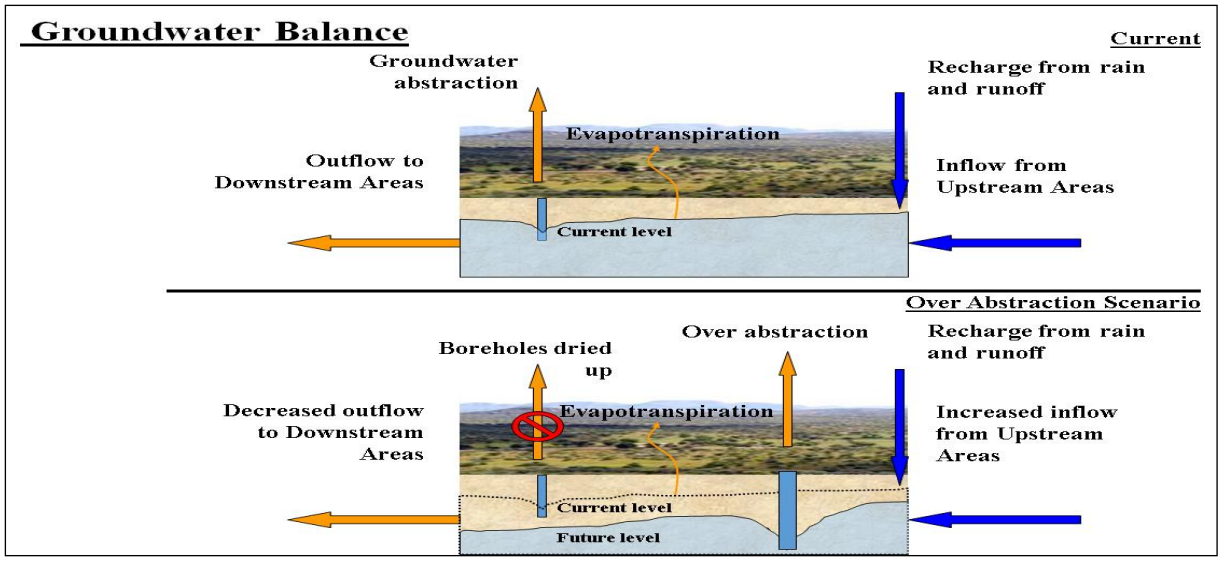



**Figure 10. Conceptual groundwater balance with over abstraction scenario**

### 9.6 FIRE

A risk of veld fires exist. Fires, used for example to cook food in areas not designated for this purpose, may spread to the nearby veld. Machinery can ignite dry vegetation if sufficient heat (e.g. exhaust pipes) or sparks are produced. Chemicals and fuels stored and used for general activities may be flammable. Electrical shorts on the electricity supply network can cause fires in buildings. Lightning can be a natural ignition source for veld fires which in turn can spread and damage infrastructure and crops or pose health impacts.

### 9.7 HEALTH AND SAFETY

Injuries related to working with machinery, chemicals, pesticides, etc. can occur. Inhalation and dermal contact with pesticides (if used) are possible where pesticides are for example applied by means of tractor mounted sprayers or via the irrigation system. Spray drift in windy conditions can reach nearby workers or the tractor driver. Vehicle accidents involving staff when transported to and from work in busses, or during movement of machinery like tractors on the farm, can occur. Venomous animals like snakes, scorpions and spiders may be present.

### 9.8 ECOSYSTEM AND BIODIVERSITY IMPACT

Pollution of the environment and groundwater, especially by fuel, pesticides and fertilizers, can deteriorate or alter the ecosystem structure and function Mono-culture cultivation may result in decreased soil biodiversity. Conversation of riparian ecosystems are vital while general conservation of large portions of the farm will result in a nett ecological benefit on the farm.

## 10 ASSESSMENT AND MANAGEMENT OF IMPACTS

The purpose of this section is to assess and identify the most pertinent environmental impacts expected from the operational, construction (care and maintenance) and potential decommissioning activities of the farm (agricultural and related activities on Hiebis-Ost). An Environmental Management Plan based on these identified impacts is present in this section. The Environmental Management Plan provides preventative and mitigation measures to limit or reduce potential impacts to acceptable levels.

For each impact, an environmental classification was determined based on an adapted version of the Rapid Impact Assessment Method (Pastakia, 1998). Assessment of impacts is based on the following categories: importance of condition (A1); magnitude of change (A2); permanence (B1); reversibility (B2); and cumulative nature (B3) (Table 13).

The environmental classification is calculated as follows:

Environmental classification = A1 x A2 x (B1 + B2 + B3)

The environmental classifications of impacts and the respective classes are provided in Table 14.

The probability ranking refers to the probability that a specific impact will happen following a risk event. These can be improbable (low likelihood); probable (distinct possibility); highly probable (most likely); and definite (impact will occur regardless of prevention measures).

**Table 13. Assessment criteria**

| Criteria | Score |
|---|---|
| **Importance of condition (A1) – assessed against the spatial boundaries of human interest it will affect** | |
| Importance to national/international interest | 4 |
| Important to regional/national interest | 3 |
| Important to areas immediately outside the local condition | 2 |
| Important only to the local condition | 1 |
| No importance | 0 |
| **Magnitude of change/effect (A2) – measure of scale in terms of benefit / disbenefit of an impact or condition** | |
| Major positive benefit | 3 |
| Significant improvement in status quo | 2 |
| Improvement in status quo | 1 |
| No change in status quo | 0 |
| Negative change in status quo | -1 |
| Significant negative disbenefit or change | -2 |
| Major disbenefit or change | -3 |
| **Permanence (B1) – defines whether the condition is permanent or temporary** | |
| No change/Not applicable | 1 |
| Temporary | 2 |
| Permanent | 3 |
| **Reversibility (B2) – defines whether the condition can be changed and is a measure of the control over the condition** | |
| No change/Not applicable | 1 |
| Reversible | 2 |
| Irreversible | 3 |
| **Cumulative (B3) – reflects whether the effect will be a single direct impact or will include cumulative impacts over time, or synergistic effect with other conditions. It is a means of judging the sustainability of the condition – not to be confused with the permanence criterion.** | |
| Light or No Cumulative Character/Not applicable | 1 |
| Moderate Cumulative Character | 2 |
| Strong Cumulative Character | 3 |

**Table 14. Environmental classification (Pastakia 1998)**

| Environmental Classification | Class Value | Description of Class |
|---|---|---|
| 72 to 108 | 5 | Extremely positive impact |
| 36 to 71 | 4 | Significantly positive impact |
| 19 to 35 | 3 | Moderately positive impact |
| 10 to 18 | 2 | Less positive impact |
| 1 to 9 | 1 | Reduced positive impact |
| 0 | -0 | No alteration |
| -1 to -9 | -1 | Reduced negative impact |
| -10 to -18 | -2 | Less negative impact |
| -19 to -35 | -3 | Moderately negative impact |
| -36 to -71 | -4 | Significantly negative impact |
| -72 to -108 | -5 | Extremely Negative Impact |

## 10.1 RISK ASSESSMENT AND ENVIRONMENTAL MANAGEMENT PLAN

The EMP provides management options to ensure impacts of the agricultural and related activities are minimised. An EMP is a tool used to take pro-active action by addressing potential problems before they occur. This should limit corrective measures needed, although additional mitigation measures might be included if necessary. The environmental management measures are provided in the tables and descriptions below. These management measures should be adhered to during the various phases of the operation and maintenance / construction of the farm. This section of the report can act as a stand-alone document. All personnel taking part in the operations of the farm should be made aware of the contents of this section, so as to plan the operations accordingly and in an environmentally sound manner.

The objectives of the EMP are:

- to include all components related to operational and construction activities of the farm;
- to prescribe the best practicable control methods to lessen the environmental impacts associated with the farm;
- to monitor and audit the performance of operational personnel in applying such controls; and
- to ensure that appropriate environmental training is provided to responsible operational personnel.

Various potential and definite impacts will emanate from the operations, maintenance / construction and decommissioning phases. The majority of these impacts can be mitigated or prevented. The impacts, risk rating of impacts, as well as prevention and mitigation measures are listed below.

As depicted in the tables below, impacts related to the operational phase are expected to mostly be of medium to low significance and can mostly be mitigated to have a low significance. The extent of impacts are mostly site specific to local and are not of a permanent nature. Due to the nature of the surrounding areas, cumulative impacts are possible and the most important of these are potential groundwater impacts.

### 10.1.1 Planning

During the phases of planning for the operations, maintenance / construction and decommissioning phases of the farm, it is the responsibility of proponent to ensure they are and remain compliant with all legal requirements. The proponent must also ensure that all required management measures are in place prior to, and during all phases, to ensure potential impacts and risks are minimised. The following actions are recommended for the planning phase and should continue during various other phases of the project:

- Ensure that all necessary permits from the various ministries, local authorities and any other bodies that governs the operations, maintenance / construction and decommissioning activities remains valid. These include a consumer fuel installation certificate, water abstraction permit and effluent disposal permit.
- Ensure all appointed contractors and employees enter into an agreement, which includes the EMP. Ensure that contractors, sub-contractors, employees and all personnel present on site understand the contents of the EMP.
- Make provisions to have a Health, Safety and Environmental Coordinator to implement the EMP and oversee occupational health and safety as well as general environmental related compliance at the site.
- Make provision for a community liaison officer to deal with complaints.
- Have the following emergency plans, equipment and personnel on site, where reasonable, to deal with all potential emergencies:
    - EMP / risk management / mitigation / emergency response plan and health safety and environment (HSE) manuals;
    - Adequate protection and indemnity insurance cover for incidents;
    - Procedures, equipment and materials required for emergencies.
- Establish and maintain a fund for future ecological restoration of the project site should project activities cease and the site is decommissioned or when environmental damage is caused during operations and environmental restoration or pollution remediation is required.
- Establish and / or maintain a reporting system to report on aspects of operations, maintenance / construction, and decommissioning as outlined in the EMP.
  Keep monitoring reports on file for bi-annual submission to MET in support of environmental clearance certificate renewal applications. This is a requirement set by MET.
- Appoint a specialist environmental consultant to update the EA and EMP and apply for renewal of the environmental clearance certificate prior to expiry.

### 10.1.2 Increased Crop Yield

The primary result of irrigation is increased crop yields when compared to dryland cropping. Availability of water through irrigation reduces the risk of crop failure and increases realisation of crop yield potential. This in turn increases the expected return on investments made in the form of for example seeds and fertilizers. Increased crop yields are of importance for the larger agricultural sector having benefits to National food security and/ or export revenue. The project is in line with Namibia's NDP5 and contributes to the economy of, and food security in, Namibia. Locally produced crops decrease the amount of crops that needs to be imported. Organic produce has a niche market and a higher local and export value. An increase in export earnings is desirable in Namibia for financing of imports of basic and essential capital goods. However, over supply of any given produce should be avoided.

| Project Activity / Resource | Nature (Status) | (A1) Importance | (A2) Magnitude | (B1) Permanence | (B2) Reversibility | (B3) Cumulative | Environmental Classification | Class Value | Probability |
|---|---|---|---|---|---|---|---|---|---|
| Daily Operations | Contribution to economy, contribution to food security in Namibia | 3 | 1 | 3 | 3 | 2 | 24 | 3 | Definite |
| Indirect Impacts | Reduced import needs, increase in trade balance. | 3 | 1 | 3 | 3 | 3 | 27 | 3 | Definite |

**Desired Outcome:** Maximum contribution to the food security and economy of Namibia. Provide a positive contribution to the trade balance of Namibia by reducing the amount of imported produce and maximising possible exports.

**Actions**

**Enhancement:**

- Namibian contractors, consultants and service providers to be employed as far as possible.
- Liaison with regional and national governmental agencies through appropriate financial and social responsibility reporting.
- Continuous improvement to maximise sustainability of the farm.

**Responsible Body:**

- Proponent

**Data Sources and Monitoring:**

- Communication records with governmental agencies.

### 10.1.4 Change in Land Use and Earning Potential

The farm, including all infrastructure, was left derelict and in a state of disrepair by previous management. The farm was not functioning as intended with regards to earning potential and contributions to the agricultural sector of Namibia. Neither were any people employed on the farm. Change in land utilisation and related economic productivity was initiated with the construction phase. Construction and operational activities have seen the rehabilitation and clearing of the property from health and environmental hazards. The current land use will lead to revenue generation and contribution to the local, regional and national economy. The earning potential of the farm area increased significantly. In addition, the flow of revenue was increased by employment, purchasing of goods and use of services. The impact is foreseen to have a positive impact on the economic sphere of the environment.

The related economic productivity of the current land use, will reach its full potential during the operational phase while the decommissioning phase will not share in such impact. However no post-closure land use has been identified yet and therefore the impact and related management and enhancement measures should be revisited closer to the decommissioning phase.

| Project Activity / Resource | Nature (Status) | (A1) Importance | (A2) Magnitude | (B1) Permanence | (B2) Reversibility | (B3) Cumulative | Environmental Classification | Class Value | Probability |
|---|---|---|---|---|---|---|---|---|---|
| Construction | Change and increase of earning potential and flow of revenue | 2 | 2 | 2 | 2 | 1 | 20 | 3 | Definite |
| Daily Operations | Change and increase of earning potential and flow of revenue | 3 | 2 | 2 | 2 | 1 | 30 | 3 | Definite |
| Indirect Impacts | Increased economic resilience potential for state, private and industry parties | 3 | 2 | 2 | 2 | 2 | 36 | 4 | Probable |

**Desired Outcome:** Contribution to local and national treasury as well as sustaining a stable earning potential for employees and industry.

**Actions**

**Enhancement:**

- The proponent must employ local Namibians where possible.
- Maintain value addition activities for the life of quarry operations where possible.
- Investigate profitable post-closure land use possibilities.

**Responsible Body:**

- Proponent

**Data Sources and Monitoring:**

- Ensure all taxes and governmental levies (where required) are paid.
- All social security and related documentation kept on file.
- Financial Auditing

### 10.1.6 Skills and Development

During the operations and maintenance / construction phases, some training is provided to a portion of the workforce to allow them to conduct certain tasks according to the required standards. Skills are periodically transferred to an unskilled workforce for general tasks. Such skills are over and above the vocational skill(s) each permanent employee on the farm has. The skilled workforce ensures higher earning potential. Development of people and technology are key to the proponent as well as to economic development of the country.

The proponent plans to operate a lodge and camping facility, which will also cater for international tourists. The establishment will employ Namibians and contribute to their exposure of international cultures and the international service industry. Employees in the tourism industry require a different skillset.

| Project Activity / Resource | Nature (Status) | (A1) Importance | (A2) Magnitude | (B1) Permanence | (B2) Reversibility | (B3) Cumulative | Environmental Classification | Class Value | Probability |
|---|---|---|---|---|---|---|---|---|---|
| Construction | Employment and transfer of skills, technological advancements | 2 | 1 | 3 | 3 | 1 | 14 | 2 | Probable |
| Daily Operations | Employment and transfer of skills | 2 | 1 | 3 | 3 | 2 | 16 | 2 | Definite |
| Indirect Impacts | Employment and transfer of skills in Namibia's agricultural and tourism sectors | 2 | 1 | 3 | 3 | 3 | 18 | 2 | Definite |

**Desired Outcome:** To see an increase in skills of local Namibians, as well as development and technological advancements in the agricultural industry.

**Actions**

**Enhancement:**

- Sourcing of employees and contractors must first be at local level and if not locally available, regional or national options should be considered. Deviations from this practice must be justified.
- Skills development and improvement programs must be made available as identified during performance assessments.
- Inform employees about parameters and requirements for references upon employment.

**Responsible Body:**

- Proponent
- Contractors

**Data Sources and Monitoring:**

- Keep records of all training provided.
- Ensure that all training is certified or managerial references provided (proof provided to the employees) inclusive of training attendance, completion and implementation.

### 10.1.7 Revenue Generation and Employment

Skilled and unskilled labour are required for the operations and maintenance / construction activities associated with the farm. Employment for the land-poor and landless increases due to the labour-intensive nature of infrastructure construction and its subsequent maintenance, as well as increased labour demand from intensified crop cultivation. Revenue is generated through the sale of agricultural products on national and international markets.

| Diversification of revenue generating activities on the farm will not only increase the | Nature (Status) | (A1) Importance | (A2) Magnitude | (B1) Permanence | (B2) Reversibility | (B3) Cumulative | Environmental Classification | Class Value | Probability |
|---|---|---|---|---|---|---|---|---|---|
| Construction | Employment and contribution to local and national economy | 2 | 1 | 2 | 2 | 1 | 10 | 2 | Definite |
| Daily Operations | Employment contribution to local economy | 2 | 2 | 2 | 2 | 1 | 20 | 3 | Definite |
| Indirect Impacts | Decrease in unemployment, contribution to local economy | 3 | 1 | 2 | 2 | 3 | 21 | 3 | Definite |

**Desired Outcome:** Contribution to national treasury and provision of employment to local Namibians.

**Actions**

**Enhancement:**

- The proponent must employ local Namibians where possible.
- If the skills exist locally, employees must first be sourced from the town, then the region and then nationally.
- Deviations from this practice must be justified.

**Responsible Body:**

- Proponent

**Data Sources and Monitoring:**

- Summary report based on employee records.

### 10.1.8 Demographic Profile and Community Health

Farming activities relies on labour. All labourers for the initial agricultural aspects will be housed on site. Similarly all labourers to be employed at the lodge and camping facility will be accommodated on site. No large change in the demographic profile of the local community is thus expected. However, jobseekers migrating to the area may lead to increased unemployment and expansion of informal settlements around Stampriet. Here, factors such as communicable disease like HIV/AIDS as well as alcoholism/drug abuse may thrive. In such instances gender based violence have been known to occur. These are typically aggravated with an influx of seasonal workers, and possible foreign construction teams and contractors. An increase in foreign people in the area, linked to unemployment, may potentially increase the risk of criminal and socially / culturally deviant behaviour. None of these potential impacts are directly linked to the project. The proponent has adopted a health and safety program for all residents of the farm, thereby ensuring greater community cohesion and safety for all (Appendix A).

Increases in standing water associated with irrigation, can serve as a breeding-ground for disease carrying vectors including mosquitos. However, the area has one of the highest evaporation rates in southern Africa and it is highly unlikely that operations will increase the existing habitats of such disease carrying vectors. Labourers and consumers can be exposed to harmful substances such as fertilizers and pesticides (if used).

| Project Activity / Resource | Nature (Status) | (A1) Importance | (A2) Magnitude | (B1) Permanence | (B2) Reversibility | (B3) Cumulative | Environmental Classification | Class Value | Probability |
|---|---|---|---|---|---|---|---|---|---|
| Construction | In-migration and social ills related to foreign contractors temporarily on site | 2 | -1 | 1 | 1 | 2 | -8 | -1 | Probable |
| Daily Operations | Social ills possibly associated with staff | 2 | -1 | 1 | 2 | 2 | -10 | -2 | Probable |
| Indirect Impacts | The spread of disease | 2 | -1 | 2 | 2 | 2 | -12 | -2 | Improbable |

**Desired Outcome:** To prevent the occurrence of social ills and prevent the spread of diseases such as HIV/AIDS. Prevention of exposure to harmful chemical elements.

**Actions:**

**Prevention:**

- Employ only local people from the area, deviations from this practice should be justified.
- Adhere to all local authority by-laws relating to environmental health, which includes, but is not limited to, sanitation requirements.
- If pesticides are considered, they should be applied responsibly and according to instructions.

**Mitigation:**

- Educational programmes for employees on various topics of social behaviour and HIV/AIDs and general upliftment of employees' social status.
- Appointment of reputable contractors.

**Responsible Body:**

- Proponent

**Data Sources and Monitoring:**

- Summary report based on educational programmes and training conducted.
- Report and review of employee demographics.

### 10.1.9 Traffic

Potential traffic impacts will mostly be limited to the turnoff from the main road to the farm. Traffic is mostly related to the delivery of fertilizers and seed, as well as the transport of crops to markets. Construction phase activities of the lodge may see an increase in delivery and tourist vehicles to the farm. The increased traffic is not considered to contribute significantly to road degradation and increased incidents on a regional scale. Roads which will be used to reach the farm are all managed by the Roads Authority of Namibia and serve the regional community.

| Project Activity / Resource | Nature (Status) | (A1) Importance | (A2) Magnitude | (B1) Permanence | (B2) Reversibility | (B3) Cumulative | Environmental Classification | Class Value | Probability |
|---|---|---|---|---|---|---|---|---|---|
| Construction | Delivery of equipment and building supplies | 2 | -1 | 2 | 2 | 1 | -10 | -2 | Improbable |
| Daily Operations | Increased traffic, road wear and tear and accidents | 2 | -1 | 2 | 2 | 1 | -10 | -2 | Improbable |

**Desired Outcome:** Minimum impact on traffic and no transport or traffic related incidents.

**Actions**

**Prevention:**

- Erect clear signage regarding access and exit points at the farm as well as speed limits on the gravel roads within the farm where required.
- Warn contractors and or an delivery vehicles new to the area about possible incidents risks close to or around the farm.

**Mitigation:**

- If any traffic impacts are expected, possibly as a result of delivery of equipment or construction material, traffic management should be performed.
- The placement of signs to warn and direct traffic will mitigate traffic impacts.

**Responsible Body:**

- Proponent

**Data Sources and Monitoring:**

- Record all traffic related complaints and the actions taken to prevent impacts from repeating itself.
- Compile a report of all incidents reported, complaints received, and actions taken.

### 10.1.10 Health, Safety and Security

Activities associated with the operations and maintenance / construction on the farm are reliant on human labour. Therefore, health and safety risks exist. Activities such as the operation of vehicles and machinery as well as handling of hazardous chemicals with inherent health hazards pose risks to employees. Encounters with wild animals and especially venomous species like snakes may pose risks to personnel on site. Security risks relates to unauthorized entry, theft and sabotage.

| Project Activity / Resource | Nature (Status) | (A1) Importance | (A2) Magnitude | (B1) Permanence | (B2) Reversibility | (B3) Cumulative | Environmental Classification | Class Value | Probability |
|---|---|---|---|---|---|---|---|---|---|
| Construction | Physical injuries, exposure to chemicals and criminal activities | 1 | -2 | 3 | 3 | 1 | -14 | -2 | Probable |
| Daily Operations | Physical injuries, exposure to chemicals and criminal activities | 1 | -2 | 3 | 3 | 2 | -16 | -2 | Probable |

**Desired Outcome:** To prevent injury, health impacts and theft.

**Actions**

**Prevention:**

- Comply with all health and safety standards as specified in the Labour Act and related legislation.
- Clearly label dangerous and restricted areas as well as dangerous equipment and products.
- Lock away or store all equipment and goods on site in a manner suitable to discourage criminal activities (e.g. theft).
- Provide all employees with required and adequate personal protective equipment (PPE) where required. This include dust masks, hearing protectors and safety wear.
- Ensure that all personnel receive adequate training on the operational procedures of equipment and machinery and the handling of hazardous substances.
- Implement a maintenance register for all relevant equipment and fuel/hazardous substance storage areas.
- Apply and adhere to all industry specific health and safety procedures and regulations applicable to the handling of food produce for markets.

**Mitigation:**

- Train selected personnel in first aid and ensure first aid kits are available on site. The contact details of all emergency services must be readily available.
- Implement and maintain an integrated health and safety management system, to act as a monitoring and mitigating tool.

**Responsible Body:**

- Proponent
- Contractors

**Data Sources and Monitoring:**

- Record any incidents with the actions taken to prevent future occurrences.
- Compile a report of all incidents reported. The report should contain dates when training was conducted and when safety equipment and structures were inspected and maintained.

### 10.1.11 Fire

Construction activities, failing electrical infrastructure and fires outside of designated areas may increase the risk of the occurrence of uncontrolled fires which may spread into the nearby fields and surrounding farms. Lightning may result in veld fires that can damage property and threaten residents and visitors to the farm.

| Project Activity / Resource | Nature (Status) | (A1) Importance | (A2) Magnitude | (B1) Permanence | (B2) Reversibility | (B3) Cumulative | Environmental Classification | Class Value | Probability |
|---|---|---|---|---|---|---|---|---|---|
| Construction | Fire risk | 2 | -2 | 2 | 2 | 1 | -20 | -3 | Probable |
| Daily Operations | Fire risk | 2 | -2 | 2 | 2 | 1 | -20 | -3 | Probable |

**Desired Outcome:** To prevent property damage, veld fires, possible injury and impacts caused by uncontrolled fires.

**Actions:**

**Prevention:**

- Prepare a holistic fire protection and prevention plan. This plan must include evacuation plans and signage, an emergency response plan and a firefighting plan.
- Personnel training (firefighting, fire prevention and responsible housekeeping practices).
- Ensure all chemicals are stored according to MSDS and SANS instructions and all spills / leaks are cleaned.
- Maintain regular site, mechanical and electrical inspections and maintenance.
- Maintain firefighting equipment and promote good housekeeping.
- Clean and maintain firebreaks at strategic locations around the property.
- Should planned burns e.g. to create firebreaks, be made, the farmers' association as well as all surrounding farmers should be notified prior to commencement.
- Allow fires used for purposes such as cooking (by staff) in designated areas only.

**Mitigation:**

- Implement the fire protection plan in the event of a fire.
- Quick response time by trained staff will limit the spread and impact of fire.

**Responsible Body:**

- Proponent
- Contractors

**Data Sources and Monitoring:**

- Maintain a register of all incidents on a daily basis. Include measures taken to ensure that such incidents do not repeat themselves.
- Compile an incidents report. The report should also contain dates when fire drills were conducted and when fire equipment was tested and training given.

### 10.1.12 Waste Production

Various waste streams result from the operational and construction / maintenance phases. Waste may include hazardous waste associated with hydrocarbon products and chemicals (fertilisers, pesticides and cleaning products) as well as soil and water contaminated with such products. Construction waste may include building rubble and discarded equipment. Domestic and general waste will be generated by the farm and related operations. Waste presents a contamination risk and when not removed regularly may become a health and / or fire hazard and attract wild animals and scavengers.

| Once in operation the lodge will also generate various waste. The cumulative waste impact will | **Nature (Status)** | **(A1) Importance** | **(A2) Magnitude** | **(B1) Permanence** | **(B2) Reversibility** | **(B3) Cumulative** | **Environmental Classification** | **Class Value** | **Probability** |
|---|---|---|---|---|---|---|---|---|---|
| Construction | Excessive waste production, contaminated materials | 1 | -2 | 2 | 2 | 2 | -12 | -2 | Definite |
| Daily Operations | Excessive waste production, contaminated materials | 1 | -2 | 2 | 2 | 2 | -12 | -2 | Definite |

**Desired Outcome:** To reduce the amount of waste produced and prevent pollution and littering.

**Actions**

**Prevention:**

- Implement waste reduction measures. All waste that can be re-used / recycled must be kept separate.
- Ensure adequate temporary storage facilities for disposed waste are available.
- Prevent windblown waste from entering the environment.
- Prevent scavenging (human and non-human) of waste at the storage facilities.

**Mitigation:**

- Waste should be disposed of regularly and at appropriately classified disposal facilities, this includes hazardous material (empty chemical containers and contaminated materials, soil and water).
- Empty chemical containers that may present a contamination / health risk must be disposed of as hazardous waste. Prevent workers and other people from collecting such containers for purposes of storing water.
- Liaise with the applicable municipality regarding waste and handling of hazardous waste.
- Should a sewage reclamation facility be used, re-use of the wastewater can be considered for gardening purposes only.

**Responsible Body:**

- Proponent
- Contractors

**Data Sources and Monitoring:**

- Maintain a register of hazardous waste disposal. This should include type of waste, volume as well as disposal method/facility.
- Record any complaints received regarding waste with notes on actions taken.
- All information to be included in a report.
- Keep design drawings and maintenance records of all sewage treatment facilities.

### 10.1.13 Change in Soil Characteristics

Physical disturbance of the soil through activities such as tillage and construction, disrupt the soil profile of the natural environment. Movement of machines, equipment, vehicles and people may compact soils. Chemicals (including fertiliser, pesticide and cleaning products) and hydrocarbon pollution resulting from the spilling of chemicals, fuel, oil or hydraulic fluids is possible. Tractor and other vehicle breakdowns or incorrect refuelling and storage of fuel are the most likely causes of hydrocarbon pollution. Waterlogging and salinization of soils may further result from inadequate drainage or over-irrigation. Waterlogging concentrates salts, drawn up from lower in the soil profile, in the plants' rooting zone. The build-up of salt in soils is difficult to rectify and may impact plant growth rates and microbiota. Saline soils may further wash into the Auob River south of the proposed irrigated areas during rainfall events. The probability and extent of such an occurrence will be low as the earth dam will serve to accumulate such material, preventing further significant detrimental impacts downstream.

Old borrow-pits are present on the farm. They are more prone to developing erosion gullies which may extend into natural, undisturbed areas.

| Project Activity / Resource | Nature (Status) | (A1) Importance | (A2) Magnitude | (B1) Permanence | (B2) Reversibility | (B3) Cumulative | Environmental Classification | Class Value | Probability |
|---|---|---|---|---|---|---|---|---|---|
| Construction | Change in chemical composition of soil as a result of irrigation. Soil pollution | 2 | -1 | 3 | 2 | 2 | -14 | -2 | Probable |
| Daily Operations | Change in chemical composition of soil as a result of irrigation. Soil pollution | 2 | -1 | 2 | 2 | 2 | -12 | -2 | Probable |

**Desired Outcome:** To avoid pollution and minimize impacts on the soil.

**Actions**.

**Prevention:**

- Practise conservation tillage or no-till farming where possible.
- Install drainage systems where needed.
- Apply improved/most effective irrigation methods.
- Formulation of best salinity management practices.
- Monitor the soil profile to inform irrigation requirements.
- Restrict traffic to dedicated roads and fields.

**Mitigation:**

- For construction activities, if any, contain construction material to a designated laydown area and prevent unnecessary movement out of areas earmarked for clearing and construction.
- Re-use of topsoil from areas earmarked for construction.
- Shaping and rehabilitation of old borrow-pits where possible.

**Responsible Body:**

- Contractor
- Proponent

**Data Sources and Monitoring:**

- Record of soil humidity profile kept.
- Record of all soil analysis kept.

### 10.1.14 Ecosystem and Biodiversity Impact

Areas which have been, or will be cleared for project related purposes (including the air-strip, irrigation areas, camping site, lodge and related infrastructure), will see a definite loss of vegetation, impacts on soil and related habitat. None of the areas identified are however of critical conservation concern and have already been affected by anthropogenic activities.

A concern related to agricultural impacts is that of the cultivation of mono-cultures. Andrén, and Kätterer (2008) investigated aspects of biodiversity related to monocultures. They found that in the soil, under a monoculture, the biodiversity is almost always extremely high, though usually lower than in natural systems. They further found that there are no consistent indications that soil functions, such as organic matter decomposition, is hampered by lower biodiversity under monocultures. Plant residue will decompose at the same rate under a monoculture as under mixed plants, if soil temperature and moisture are the same. The presence of a large flowering field of produce may in effect attract and accommodate an increased number and abundance of species than arid and harsh surrounding natural environment. When considering the limited area of proposed monoculture in relation to the natural and conserved area of the farm, monoculture agriculture is not considered likely to have a significant impact on biodiversity.

The site selection of the lodge and related infrastructure will be conducted with cognisance of the limited riparian habitat which is important to conserve. Conservation of this zone will not only protect the related habitats, but will contribute to the tourism potential of the lodge. Large portions of the farm is dedicated to conservation and proposed tourism related activities. Significant capital investment has been made to ensure the protection and conservation of these areas. The nett ecological benefits of the entire project are greater than the limited footprint of the development, especially when compared to the previous condition of the farm.

| Project Activity / Resource | Nature (Status) | (A1) Importance | (A2) Magnitude | (B1) Permanence | (B2) Reversibility | (B3) Cumulative | Environmental Classification | Class Value | Probability |
|---|---|---|---|---|---|---|---|---|---|
| Construction | Impact on ecosystems. Loss of biodiversity and poaching | 2 | -1 | 3 | 2 | 1 | -12 | -2 | Definite |
| Daily Operations | Impact on ecosystems. Increased biodiversity conservation. | 2 | 1 | 2 | 2 | 2 | 12 | 2 | Probable |

**Desired Outcome:** To limit anthropogenic impacts while conserving habitats and ecosystems.

**Actions**.

**Prevention:**

- Obtain the necessary permits from the Directorate of Forestry, Ministry of Agriculture, Water and Forestry for removal of protected species, if any.
- Educate all contracted and permanent employees on the value of biodiversity.
- Strict conditions prohibiting harvesting and poaching of fauna and flora should be part of employment contracts. This includes prohibitions or regulations on the collection of firewood.
- Regular inspection of fences, game footpaths and other sites for snares, traps or any other illegal activities.
- Take disciplinary action against any employees failing to comply with contractual conditions related to poaching and the environment.
- Delineate riparian habitat with conservation value and limit infrastructure development within these zones.

- Fence off the air-strip or put controls in place to clear the strip prior to landing of any aircraft.

**Mitigation:**

- For construction activities, if any, contain construction material to a designated laydown area and prevent unnecessary movement out of areas earmarked for clearing and construction.
- Report any extraordinary animal sightings to the Ministry of Environment and Tourism.
- Mitigation measures related to waste handling and the prevention of groundwater, surface water and soil contamination should limit ecosystem and biodiversity impacts.
- Avoid scavenging of waste by fauna.

**Responsible Body:**

- Contractor
- Proponent

**Data Sources and Monitoring:**

- Report on all extraordinary animal or plant sightings or instances of poaching.
- Map conservation areas and keep on file.
- Keep frequent records of borehole water levels and abstracted water volumes to identify any trends or consistent reduction in water levels.

### 10.1.15 Groundwater and Surface Water Contamination

Chemical spills, inclusive of fertilizers and pesticides, may result in very high but localised contamination of soil, increasing the risk of groundwater contamination if spill clean-up is not performed. Fertilizers and pesticides can leach into the ground and eventually reach and contaminate groundwater. Although the proponent has indicated that organic farming is proposed, the impact assessment considered pesticide application as per the precautionary principle.

Excessive fertilizer application can result in greater nitrogen loadings. This is a groundwater pollution risk, especially where the water table is shallow.

Leakages and spillages hazardous substances from tractors and earth moving equipment and accidental fuel, oil or hydraulic fluid spills during the construction phase.

Leakage from sewerage systems may contaminate the groundwater.

| Project Activity / Resource | Nature (Status) | (A1) Importance | (A2) Magnitude | (B1) Permanence | (B2)Reversibility | (B3) Cumulative | Environmental Classification | Class Value | Probability |
|---|---|---|---|---|---|---|---|---|---|
| Construction | Hazardous material, spillages, hydrocarbon leakages from vehicles and machinery. | 2 | -2 | 2 | 2 | 1 | -20 | -3 | Improbable |
| Daily Operations | Hazardous material, spillages, hydrocarbon leakages from vehicles and machinery. Over application of fertilizer, pesticides, herbicides, etc. Sewerage system malfunction. | 2 | -2 | 2 | 2 | 2 | -24 | -3 | Probable |

**Desired Outcome:** To prevent the contamination of groundwater, surface water and soil.

**Actions**

**Prevention:**

- Appoint reputable contractors.
- Service vehicles on a suitable spill control structure at all times.
- Regular inspections and maintenance of all vehicles to ensure no leaks are present.
- All hazardous chemicals should be stored in a sufficiently bunded area.
- Follow prescribed dosage of fertilizers, pesticides and herbicides to prevent over application.
- Maintain sewerage systems and conduct regular monitoring.
- Remove and dispose all hazardous waste of timeously and at a recognised hazardous waste disposal facility, including any polluted soil or water.

**Mitigation:**

- Immediately clean any spills that occurs.
- Consult relevant Material Safety Data Sheet information and a suitably qualified specialist where needed.

**Responsible Body:**

- Proponent
- Contractors

**Data Sources and Monitoring:**

- Effluent Disposal Permit
- Maintain Material Safety Data Sheets for hazardous chemicals.

- Soil should be sampled and analysed annually to ensure the correct amounts of fertilizer is applied and soil and groundwater quality are maintained.
- Sample and analyse groundwater annually to test for nitrate concentrations from the fertilizers and for traces of chemicals used in pesticides and herbicides.
- Keep registers on the type, quantities and frequency of application of fertiliser, pesticides and any other chemicals utilised in crop production.
- Maintain a register of all incidents on a daily basis. This should include measures taken to ensure that such incidents do not repeat themselves.
- Report on and clean up all spills or leaks immediately.

### 10.1.16 Groundwater Availability

The over abstraction of groundwater for irrigation and other activities may lead to a drop in water table. This may negatively impact on surrounding users as well as existing habitats that depend on groundwater. For example the availability of groundwater may have an impact on the farm and surrounding farms, as well as on a bigger scale due to the cumulative impact. Over abstraction from surrounding users may contribute to the decline in water levels (cumulative impact).

| Project Activity / Resource | Nature (Status) | (A1) Importance | (A2) Magnitude | (B1) Permanence | (B2)Reversibility | (B3) Cumulative | Environmental Classification | Class Value | Probability |
|---|---|---|---|---|---|---|---|---|---|
| Daily Operations | Over-abstraction of the local aquifer, decrease in the local hydraulic head. | 2 | -2 | 2 | 2 | 2 | -24 | -3 | Probable |

**Desired Outcome:** To utilise the groundwater sustainably.

**Actions**

**Prevention:**

- Spread the water abstraction points over a larger area to diffuse the impact.
- Monthly water level monitoring.
- Maintain safe abstraction rates prescribed by MAWF in the abstraction permit.

**Mitigation:**

- Reduce abstraction rates when the water levels decrease with more 10 m below the long-term averages of the specific boreholes.

**Responsible Body:**

- Proponent

**Data Sources and Monitoring:**

- Monthly water rest water level monitoring.
- Review baseline water level values every 3 years based on all historic water level data collected.
- Maintain a register of all groundwater related impacts.

### 10.1.17 Heritage

Construction activities and earthworks may uncover objects of heritage or archaeological significance.

| Project Activity / Resource | Nature (Status) | (A1) Importance | (A2) Magnitude | (B1) Permanence | (B2)Reversibility | (B3) Cumulative | Environmental Classification | Class Value | Probability |
|---|---|---|---|---|---|---|---|---|---|
| Construction | Unearthing and potentially damaging objects of significance | 2 | -2 | 3 | 3 | 1 | -24 | -3 | Probable |

**Desired Outcome:** To conserve any objects of heritage or archaeological value

**Actions**

**Prevention:**

- All employees must be vigilant and stop any potential damaging activity if an object of potential significance is encountered.

**Mitigation:**

- Implement chance-find procedures. No work should be allowed on site until the site has been cleared to continue activities.
- A heritage specialist should be contracted to consider all objects found and to document all possible heritage or archaeological resources of value.

**Responsible Body:**

- Proponent

**Data Sources and Monitoring:**

- Maintain a register of all objects unearthed and reported to the National Heritage Council.

### 10.1.18 Cumulative Impact

Possible cumulative impacts associated with the operational phase and any maintenance / construction activities are linked to direct and indirect impacts on the social, biophysical and economic spheres of the environment. Impacts may further be grouped according to their positive contribution or detrimental effect on the state of the environment.

Positive cumulative considerations related to the proposed development include changes in land use, economic contributions, employment and conservation. All these aspects contribute n a local, regional and national scale to the various sectors involved with the project.

| **Project Activity / Resource** | **Nature (Status)** | **(A1) Importance** | **(A2) Magnitude** | **(B1) Permanence** | **(B2) Reversibility** | **(B3) Cumulative** | **Environmental Classification** | **Class Value** | **Probability** |
|---|---|---|---|---|---|---|---|---|---|
| Construction | The build-up of positive impacts to become more significant | 3 | 1 | 2 | 2 | 1 | 15 | 2 | Probable |
| Daily Operations | The build-up of positive impacts to become more significant | 3 | 1 | 2 | 2 | 1 | 15 | 2 | Probable |
| Negative cumulative impacts related to the farm and related operations are mainly linked | **Nature (Status)** | **(A1) Importance** | **(A2) Magnitude** | **(B1) Permanence** | **(B2) Reversibility** | **(B3) Cumulative** | **Environmental Classification** | **Class Value** | **Probability** |
| Construction | The build-up of negative impacts to become more significant | 2 | -1 | 2 | 2 | 1 | -10 | -2 | Improbable |
| Daily Operations | The build-up of negative impacts to become more significant | 2 | -1 | 2 | 2 | 1 | -10 | -2 | Probable |

**Desired Outcome:** To minimise cumulative all impacts associated with the farm.

**Actions**

**Mitigation:**

- Addressing each of the individual impacts as discussed and recommended in the EMP would reduce the cumulative impact.
- Reviewing biannual reports for any new or re-occurring impacts or problems would aid in identifying cumulative impacts. Planning and improvement of the existing mitigation measures can then be implemented.

**Responsible Body:**

- Proponent

**Data Sources and Monitoring:**

- Create a summary report based on all other impacts to give an overall assessment of the impacts of the operational phase.

### 10.2 DECOMMISSIONING AND REHABILITATION

Closure and decommissioning of proposed activities on the farm as a whole is not foreseen during the validity of the environmental clearance certificate or in the near future. However, it is more likely that certain components may be decommissioned. Decommissioning is therefore included for this purpose as well as the fact that construction activities may also include modification and decommissioning. Prior to decommissioning, assess the future land use plans and implement rehabilitation measures if the land will not be used for similar future purposes. Decommissioning will entail the complete removal of all infrastructure including buildings and underground infrastructure. Any pollution present on the site must be remediated. The Environmental Management Plan for the farm will have to be reviewed at the time of full decommissioning to cater for changes made to the site and to implement guidelines and mitigation measures.

### 10.3 ENVIRONMENTAL MANAGEMENT SYSTEM

The proponent could implement an Environmental Management System (EMS) for their operations. An EMS is an internationally recognized and certified management system that will ensure ongoing incorporation of environmental constraints. At the heart of an EMS is the concept of continual improvement of environmental performance with resulting increases in operational efficiency, financial savings and reduction in environmental, health and safety risks. An effective EMS would need to include the following elements:

- A stated environmental policy which sets the desired level of environmental performance;
- An environmental legal register;
- An institutional structure which sets out the responsibility, authority, lines of communication and resources needed to implement the EMS;
- Identification of environmental, safety and health training needs;
- An environmental program(s) stipulating environmental objectives and targets to be met, and work instructions and controls to be applied in order to achieve compliance with the environmental policy; and
- Periodic (internal and external) audits and reviews of environmental performance and the effectiveness of the EMS.
- The Environmental Management Plan

## 11 CONCLUSION

Agricultural activities on the farm will contribute positively to various sectors in Namibia. Food and fodder will be produced for national and international markets. It provides employment opportunities and skills development to a local workforce. Revenue is generated that contributes to the Namibian economy.

Negative impacts associated with the operations and maintenance / construction activities can successfully be mitigated. Implementing a safety, health, environment and quality (SHEQ) policy will contribute to effective management procedures to prevent and mitigate impacts. All regulations related to agriculture and health and safety legislation should be implemented. Groundwater and soil pollution must be prevented at all times. Fire prevention is important, fire response plans must be in place, and regular training provided. All staff must be made aware of the importance of biodiversity and the poaching or illegal harvesting of animal and plant products prohibited. Waste must be discarded appropriately. Certain wastes can be re-used or recycled where possible. Hazardous waste must be disposed of at an approved hazardous waste disposal site. A monthly groundwater monitoring and review process is crucial and preferably in conjunction with other farmers in the area. This will act as an early warning system should over-abstraction occur, especially during dry seasons. Care must be exercised when long term irrigation takes place on unsuitable soil as soil deterioration may take place. Soil suitability should therefore be assessed. The environmental management plan (Section 10) should be used as an on-site reference document for the operations of the farm. Parties responsible for transgression of the environmental management plan should be held responsible for any rehabilitation that may need to be undertaken. The proponent could use an in-house Health, Safety, Security and

Environment Management System in conjunction with the environmental management plan. All operational personnel must be taught the contents of these documents.

Should the Department of Environmental Affairs (DEA) agree with the impacts and related mitigation measures; they may issue an environmental clearance certificate to the proponent. The environmental clearance certificate will render this document legally binding on the proponent. The proponent must focus on Section 10, which includes the EMP, for continued execution of their activities. The assessment process's aim is not to stop the activity, or any of its components, but to rather determine its impact and guide sustainable and responsible development as per the spirit of the EMA.

**Table 15. Impact summary class values**

| Impact Category | Impact Type | Construction | | Operations | |
|---|---|---|---|---|---|
| | *Positive Rating Scale: Maximum Value* | 5 | | 5 | |
| | *Negative Rating Scale: Maximum Value* | | -5 | | -5 |
| EO | Increased Crop Yield | | | 3 | |
| EO | Change in Land Use and Earning Potential | 3 | | 3 | |
| EO | Skills and Development | 2 | | 2 | |
| EO | Revenue Generation and Employment | 2 | | 3 | |
| SC | Demographic Profile and Community Health | | -1 | | -2 |
| SC | Traffic | | -2 | | -2 |
| SC | Health, Safety and Security | | -2 | | -2 |
| PC | Fire | | -3 | | -3 |
| PC | Waste Production | | -2 | | -2 |
| PC | Change in Soil Characteristics | | -2 | | -2 |
| BE | Ecosystem and Biodiversity Impact | | -2 | | 2 |
| PC | Groundwater and Surface Water | | -3 | | -3 |
| BE/EO | Groundwater Availability | | | | -3 |
| SC | Heritage | | -3 | | |

*BE = Biological/Ecological EO = Economical/Operational PC = Physical/Chemical SC = Sociological/Cultural*

# 12 REFERENCES

Andrén, O., Kätterer, T., 2008. *Agriculture Systems*. Encyclopedia of Ecology, Pages 96-101 (2008)

Botha P, van der Merwe J.A.; November 2019; Agricultural Activities On Farm Campbellsdrei Hardap Region: Hydrogeological Specialist Study

Curtis B. & Mannheimer C. 2005. Tree Atlas of Namibia. National Botanical Research Institute, Windhoek. 674 pages.

Digital Atlas of Namibia Unpublished Report. Ministry of Environment & Tourism

Directorate of Environmental Affairs, 2008. Procedures and Guidelines for Environmental Impact Assessment (EIA) and Environmental Management Plans (EMP), Directorate of Environmental Affairs, Ministry of Environment and Tourism, Windhoek.

Namibia Statistics Agency. 2011. Population and Housing Census Main Report.

Namibia Statistics Agency. Namibia household Income and Expenditure Survey 2009/2010.

Pastakia, C.M.R.; 1998; The Rapid Impact Assessment Matrix (RIAM) – A new tool for Environmental Impact Assessment.

# Appendix A: Certificates

REPUBLIC OF NAMIBIA

## MINISTRY OF AGRICULTURE, WATER AND FORESTRY

**Telephone:** (061) 2087111
**Fax:** (061) 2087227
**Enquiries:** E Coetzee
**Reference:** PM 1137

**Department of Water Affairs**
**Private Bag 13193**
**Windhoek**
**9000**

**PERMIT NUMBER: 11321**

**DATE:** 15 December 2017

**PERMIT ISSUED IN TERMS OF REGULATIONS 5 AND 9 OF GOVERNMENT NOTICE R1278 OF 23 JULY 1971 AS PROMULGATED UNDER SECTION 30(2) OF THE WATER ACT, 1956 (ACT 54 OF 1956), AS AMENDED**

| | | |
|---|---|---|
| NAME OF PERMIT HOLDER | : | Mr A P van Straten |
| ADDRESS | : | P. O. Box 32098, Windhoek |
| REGISTERED PROPERTY | : | Campbelsdrei No. 1137 |
| DISTRICT | : | Mariental |
| CONTROL AREA | : | Stampriet Artesian Area |
| VALIDITY PERIOD | : | 5 (five) years |
| BOREHOLE TO BE USED | : | Serial number WW 147 |
| PURPOSE FOR WHICH WATER MAY BE USED | : | Irrigation purposes |
| ABSTRACTION PER YEAR | : | 50 000 $m^3$ maximum |

All official correspondence must be addressed to the Permanent Secretary.

2.

This permit authorizes the holder (or his successors in title) to abstract and use water for the purpose as stated above, from the existing borehole identified as WW 147 on the farm planning map, attached as Annexure A, subject to the following conditions:

1. The validity period shall be from 15 December 2017 to 14 December 2022.

2. An application for the extension of the validity period shall be in the possession of the Permanent Secretary at least 6 (six) months before the expiry date of the permit.

3. The permit is incident to the property and if the present owner sells the property, the permit shall be handed over to the new owner.

4. Enclosed please find the number plate for the borehole. The number plate shall be prominently placed for easy identification of the borehole. (Do not attached to movables such as the pump or engine or to the concrete block around the casing).

5. All water abstracted shall pass through a water meter and the permit holder shall bear all costs for the supply, installation and maintenance of this meter. The Permanent Secretary shall be informed beforehand if a water meter is to be installed so that an inspection, if necessary, can be conducted. Installation of the meter shall be to the satisfaction of the Permanent Secretary.

6. The permit holder shall keep monthly readings in cubic metres of the above-mentioned water meter and enter it quarterly on the prescribed return form, which shall be submitted on or before the 10th day of the following quarter, in respect of the previous quarter, to the Control Officer: Abstraction Control. If no water was abstracted during a quarter, a nil return form shall be submitted. Should you have inquiries regarding the completion of the above-mentioned form, you may contact the Geohydrology or Law Administration Division at telephone numbers (061) 2087121 or 2087184.

7. The permit holder shall record the water level of the pumped source once in three months at a time before the pump is switched on in order to obtain the rest water level and enter it on the above-mentioned return form.

8. Where a borehole is situated in a riverbed no embankments shall be constructed around the borehole in the riverbed which could result in the river damming up or its normal flow being impeded.

9. All installations, reservoirs, pipes, taps troughs and reticulation systems shall be leak proof to prevent any spillage of water. The permit holder shall take the necessary precautions to use the water on his property to the best advantage.

10. The Permanent Secretary or his authorized representative in consultation with the Minister shall have the right to:

    (a) withdraw, amend or replace any condition of this permit or withdraw this permit in its entirety, after reasonable notice to the permit holder.

    (b) inspect the source and installations at all reasonable times to determine whether the permit conditions are adhered to.

3.

11. The Permanent Secretary shall not accept liability for damage or loss suffered by the permit holder should the relevant sources wane or run dry or the period of validity of the permit not be extended or renewed.

12. Should the permit holder not comply with any of the permit conditions:

    (a) the Permanent Secretary may seal the borehole until the conditions are complied with;

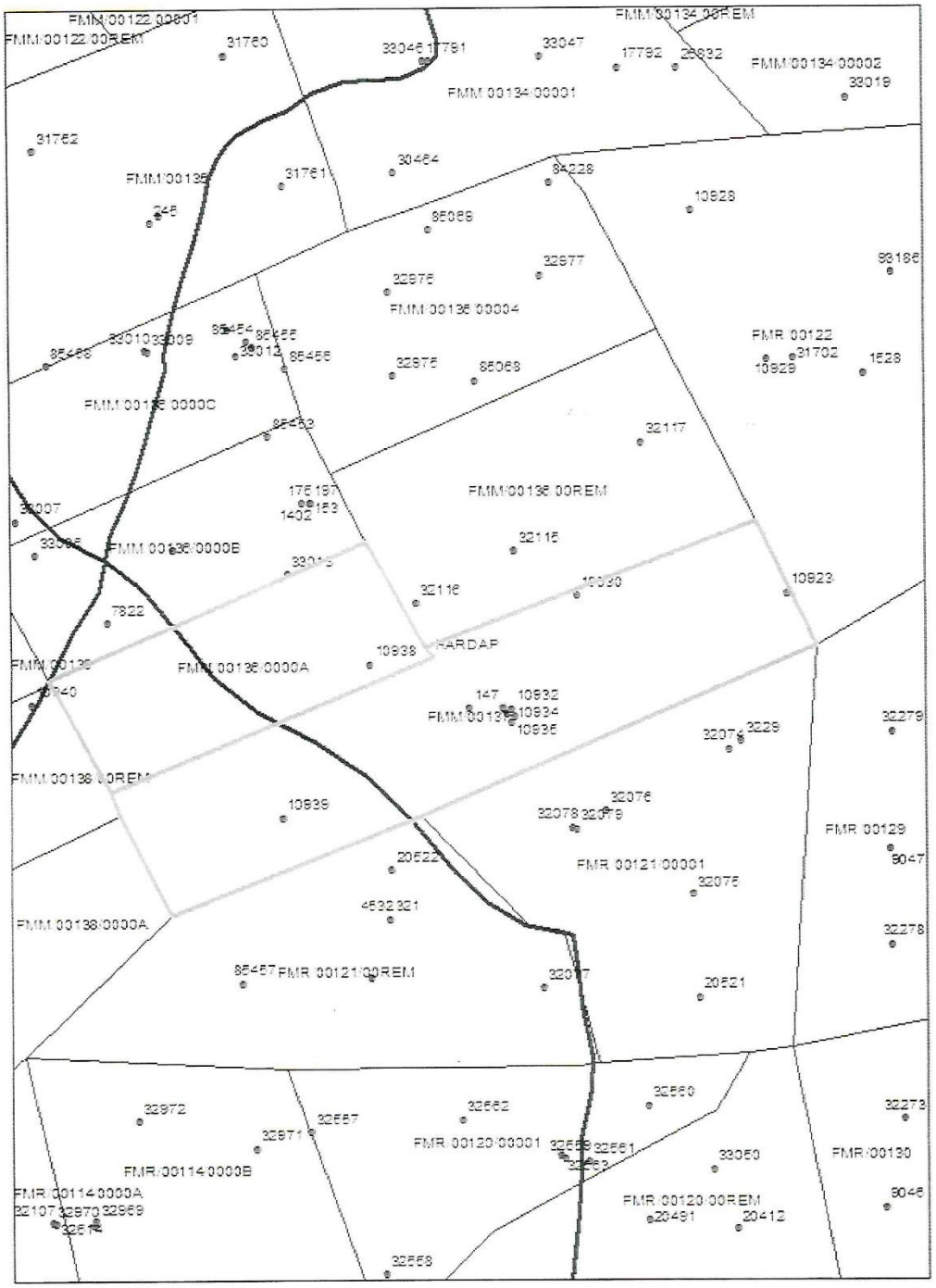
    (b) the permit holder may be held liable for any costs which the Permanent Secretary may incur as a result thereof, and

    (c) the permit holder shall be guilty of an offence and shall, on conviction, be liable to the penalties prescribed in Section 170 of the Water Act, 1956 (Act 54 of 1956).


Percy W Misika
**PERMANENT SECRETARY**

Campbelsdrei 1137

# Hardap Region



A. P. van Straten t/a
Bitachon Farming
14 Perkin Street
P.O. Box 32098
Windhoek

**CAMPBELLS DREI**
**HEALTH AND SAFETY**

All of the information contained in this document has been shared orally with our employees and are we in the process of printing hard copies to hand out, and also on a regular basis work together through the information.

A few points to remember by the employer and employees regarding health and safety:

1. Be well informed about the various hazards in your workplace and the possible solutions for controlling those hazards.

2. Work together with your employer to identify and control hazards.

3. You may occasionally need to share some of this information with your supervisors and employer in the process of working towards a safe and healthy workplace.

Below a list of hazards identified on the farm:

- **Machine hazards**

  Tractor driver – One of the most serious problems with tractors is that they often overturn and, if they have no safety cab, the driver can easily be crushed. Tractor drivers are identified and must be able to operate the machine, current tractor drivers on Campbells Drei, Werner de Wee, Niklaas Swartbooi, Elvis van Wyl and Frank van Straten. Safety and use of the tractors are reminded to these drivers on an ongoing basis.

  Hammer mill - Start the hammer mill and allow time for the mill to get up to full speed by making use of throttle control on tractor. Feed material into the mill using the provided pushing device. Use caution to not over load the mill with too much material by listening to the noise of the tractor. Put on safety glasses, dust mask and gloves while operating the hammer mill.

  When servicing (cleaning and greasing) the hammer mill ensure that it is removed from all potential energy sources. Wear gloves and safety glasses while servicing.

- **Energy hazards**

  Campbells Drei only makes use of solar energy, we have two pump stations and make use of direct current (DC) to run our water pumps and center pivot. Electricity hazard signs have been put on the entrance of these stations and all employees have been informed of the electrical dangers in these stations.

  To reduce the risk only certain employees' have mandate to switch the pumps on and off in the pump station.

  All employees have been warned of the following risks at the pump stations (DC) as well as at the houses where alternating current (AC) is present:

A. P. van Straten t/a
Bitachon Farming
14 Perkin Street
P.O. Box 32098
Windhoek

Electric shock • Electrical burns • Fire/explosion • Supply voltage • Protection against direct contact • Protection against indirect contact

- **Materials handling hazards**

  At Campbells Drei we strive to farm organic, so we do not make use of fertilizers, pesticides or any other hazardous substances/liquids.

- **Work practice hazards**

**FIRE CAUSES**
Deliberate
Carelessness (including smoking)
Burning rubbish/waste
Poor housekeeping
Electrical faults
Misuse of electrical installations
Welding

**FIRE PREVENTION**
General storage of combustibles
- Fuel is stored in the garage away from any potential sparks and fire.

Good housekeeping practices
- When burning rubbish/waste ensure it is a wind still day
- All employees to be on the alert when burning rubbish/waste.

Electrical equipment
- Welders are informed to be very careful when welding and to ensure that there are not combustibles near the welding area.
- When grinding same practice as with welding.

Smoking
- No smoking is allowed in the veld.
- All employees are warned where they smoke and that they should be alert when they light a smoke.

---

***Workers have...***

*The right to know by way of induction, risk assessments and safety policies.*

*The right to participate in investigations, risk assessment and consultations.*

*The right to refuse unsafe work.*

---

**ACCIDENTS**
We regularly discuss the following with our employees to avoid accidents:

- Lack of information/training, thus we always ensure that they understand their instructions and know what to do.

A. P. van Straten t/a
Bitachon Farming
14 Perkin Street
P.O. Box 32098
Windhoek

- Working too quickly in an attempt to finish a job can also lead to accidents.
- Working whilst ill.
- Distractions like cell phones, thus all employees are warned about the risk of working on a cell phone and a hammer mill for instance.
- Unsuitable clothing.
- We also have a no alcohol policy on the farm.

---

**EMPLOYER DUTIES:**

• Risk assess activities posing a risk of injury
• Reduce risk
• Provide information and training
• Provide training

**EMPLOYEE DUTIES:**

• Take reasonable care
• Co-operate with the employer
• Make full and proper use of any systems of work
• Follow training guidelines
• Report anything that appears to dangerous

---

# Appendix B: Hydrogeological Specialist Study

# AGRICULTURAL AND HOSPITALITY ACTIVITIES ON FARM CAMPBELLSDREI HARDAP REGION

## HYDROGEOLOGICAL SPECIALIST STUDY

**Assessed by:**

**Assessed for:**

**Alwyn van Straten**

December 2019

| | | |
|---|---|---|
| **Project:** | **AGRICULTURAL AND HOSPITALITY ACTIVITIES ON FARM CAMPBELLSDREI HARDAP REGION: HYDROGEOLOGICAL SPECIALIST STUDY** | |
| **Report Version/Date** | V1/<br>December 2019 | |
| **Prepared for** | Alwyn van Straten<br>P.O. Box 32098<br>Windhoek<br>Namibia | |
| **Lead Consultant** | Geo Pollution Technologies (Pty) Ltd<br>PO Box 11073<br>Windhoek<br>Namibia | TEL.: (+264-61) 257411<br>FAX.: (+264) 88626368 |
| **Main Project Team** | **Pierre Botha (Leader)**<br>(B.Sc. Geology/Geography); (B.Sc. (Hons) Hydrology/Hydrogeology)<br>**Jannie van der Merwe**<br>(B.Sc. Geology/Geography); (B.Sc. (Hons) Hydrology/Hydrogeology) | |
| **Cite this document as:** | Botha P, van der Merwe J.A.; December 2019; Agricultural And Hospitality Activities On Farm Campbellsdrei Hardap Region: Hydrogeological Specialist Study | |
| **Copyright** | Copyright on this document is reserved. No part of this document may be utilised without the written permission of Geo Pollution Technologies (Pty) Ltd. | |
| **Report Approval** | Pierre Botha<br>Managing Director | |

# TABLE OF CONTENTS

**1 INTRODUCTION ..... 1**

**2 SCOPE OF WORK ..... 1**

**3 METHODOLOGY ..... 1**

**4 DESCRIPTION OF NATURAL ENVIRONMENT ..... 2**

4.1 Locality and Surrounding Land Use ..... 2
4.2 Climate ..... 3
4.3 Topography & Drainage ..... 3
4.4 Geology and Hydrogeology ..... 3
4.5 Soils ..... 9
4.6 Groundwater Usage ..... 9

**5 ASSESSMENT OF BOREHOLE DATA ..... 10**

5.1 Monitor Borehole Data ..... 10

**6 WATER SUITABILITY FOR IRRIGATION PURPOSES ..... 15**

**7 SOIL SUITABILITY FOR IRRIGATION PURPOSES ..... 17**

**8 ASSESSMENT OF IMPACTS ..... 19**

8.1 Groundwater Abstraction ..... 21
8.2 Groundwater, Surface Water and Soil Contamination ..... 25

**9 CONCLUSION ..... 26**

**10 REFERENCES ..... 27**

# LIST OF FIGURES

Figure 1. Project location ..... 1
Figure 2. Groundwater basin with rainfall and inferred groundwater flow ..... 2
Figure 3. Average monthly rainfall (Atlas of Namibia) ..... 3
Figure 4. Hydrogeological map (after JICA; 2002) ..... 5
Figure 5. Geological cross section (JICA; 2002) ..... 6
Figure 6. Stratigraphy of the Stampriet Artesian Basin (JICA; 2002) ..... 7
Figure 7. Groundwater quality ..... 8
Figure 8. Dominant soil and rock type (Atlas of Namibia) ..... 9
Figure 9. Borehole locations ..... 10
Figure 10. Regional water level changes and monthly rainfall (MAWF; 2019) ..... 12
Figure 11. Regional water level profile ..... 12
Figure 12. Monitoring borehole, geological section springs and elevation ..... 13
Figure 13. Geological cross section over water level monitoring station (JICA; 2002) 14
Figure 14. Piper diagram for irrigation water ..... 16
Figure 15. Groundwater sodium adsorption ratio ..... 16
Figure 16. Soil pH effects on availability of elements (after University of California; 2019) ..... 17
Figure 17. Soil texture triangle ..... 18
Figure 18. Conceptual model of an artesian aquifer. (Peck, H. 2009) ..... 22
Figure 19. Conceptual model of Auob aquifer system (Peck, H. 2009) ..... 23
Figure 20. Conception model of the Auob aquifer extent (Peck, H. 2009) ..... 24

# LIST OF TABLES

Table 1. Summary of climate conditions (Atlas of Namibia) ..... 3
Table 2. Groundwater statistics ..... 6
Table 3. Borehole information summary ..... 10
Table 4. Soil sample results ..... 18

TABLE 5. ENVIRONMENTAL CLASSIFICATION OF IMPACTS ACCORDING TO THE RAPID IMPACT ASSESSMENT METHOD OF PASTAKIA 1998. ..... 19
TABLE 6. ASSESSMENT CRITERIA ..... 20
TABLE 7. ASSESSMENT – GROUNDWATER ABSTRACTION ..... 24
TABLE 8. ASSESSMENT – GROUNDWATER, SURFACE WATER AND SOIL CONTAMINATION ..... 25

# 1 INTRODUCTION

Mr. Alwyn van Straten (the Proponent) appointed Geo Pollution Technologies (Pty) Ltd to undertake a hydrogeological specialist study for the existing and proposed agricultural and hospitality activities on Farm Campbellsdrei, FMM/00137, in the Hardap Region (Figure 1). Currently, citrus orchards and lucerne fields are irrigated on the farm from six production boreholes, by means of micro-sprayer irrigation and centre pivot systems respectively. The proponent further proposes to increase the citrus orchards and to develop the farm to also cater for the tourism and hospitality industry.

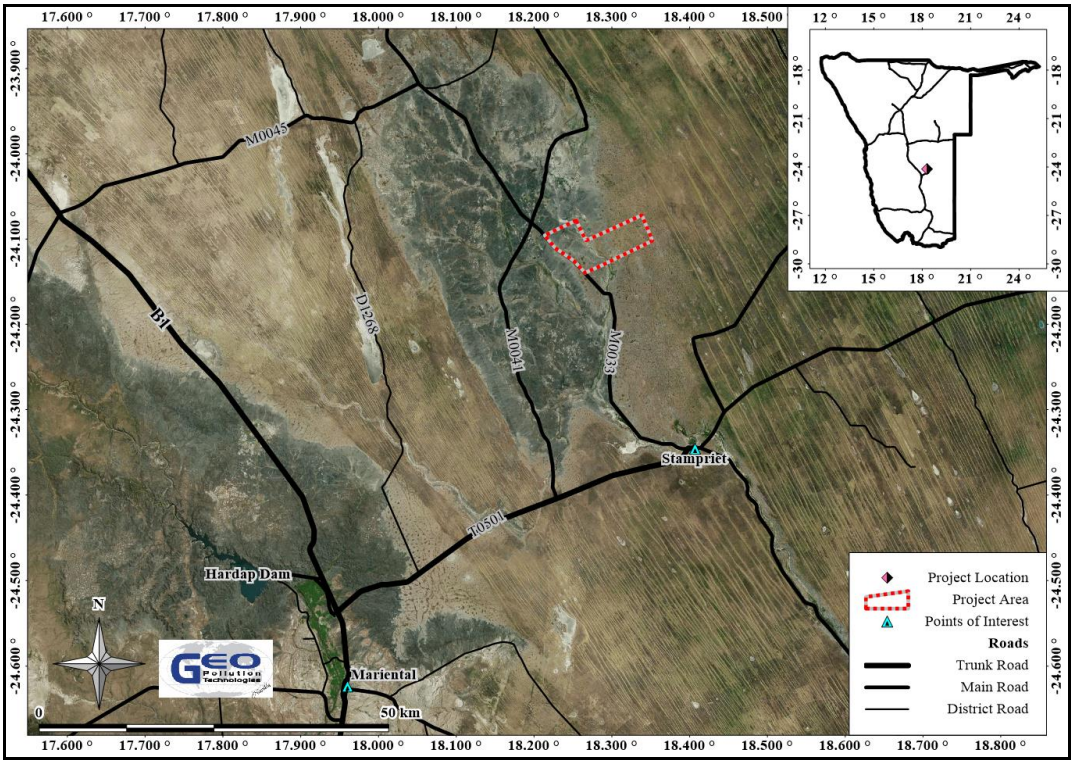



**Figure 1. Project location**

# 2 SCOPE OF WORK

The aims of the study were to:

1. Conduct a hydrogeological assessment based on data obtained from an in-field hydrocensus survey.
2. Gather historic information and compile a hydrogeological assessment based on the information.

# 3 METHODOLOGY

All available geological and hydrogeological information/reports for the investigation area were obtained and reviewed. The hydrogeological catchment and sub-catchments within the investigation area were reviewed and delineated. This was based on historic groundwater level data contained in the DWA database and hydrocensus data done on behalf of the proponent.

# 4 DESCRIPTION OF NATURAL ENVIRONMENT

## 4.1 LOCALITY AND SURROUNDING LAND USE

Farm Campbellsdrei FMM/00137 (24.11576 °S; 18.280905 °E) is located approximately 26 km north of Stampriet, along the M0033 main road (route number C15) leading to Hoachanas. All adjacent properties are farms and land use thus consists of agriculture. The farm is located in the Southeast Kalahari Groundwater Basin. The Stampriet artesian basin form part of the mentioned groundwater basin, see Figure 2.

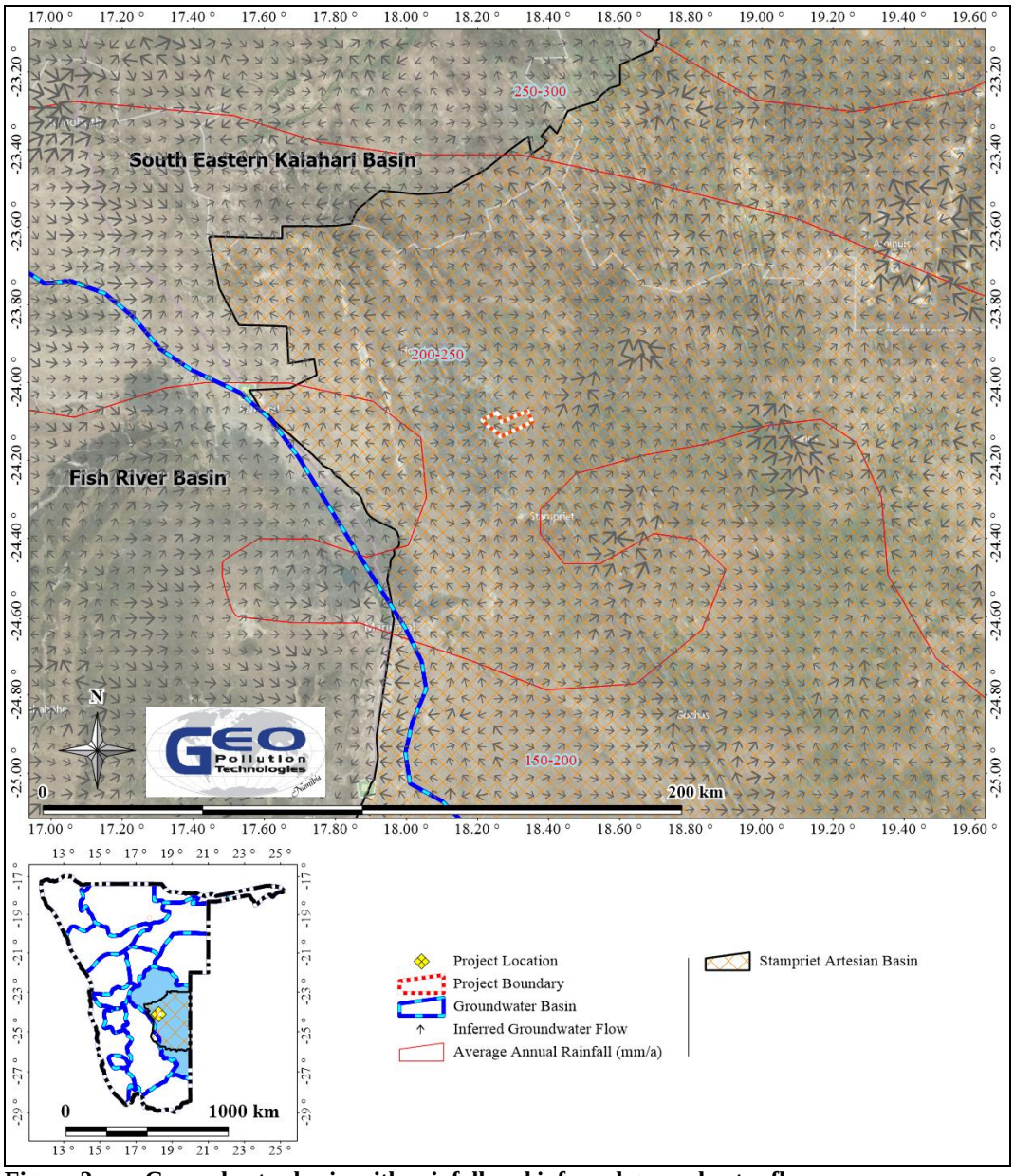



**Figure 2. Groundwater basin with rainfall and inferred groundwater flow**

### 4.2 CLIMATE

The farm is situated in a semi-arid climatic region. Days are mostly warm with very hot days during the summer months, while nights are generally cooler. Rainfall occurs from October to April. The highest rainfall is normally received during the months of January, February and March, while June, July and August are generally dry (Figure 3). Average annual rainfall received in the area is below the Namibian average and ranges between 200 and 250 mm/a, with a rainfall variability of 50 - 60%. Table 1 and Figure 3 contain a summary of the climate conditions for the area.

**Table 1. Summary of climate conditions (Atlas of Namibia)**

| | |
|---|---|
| **Precipitation** | 200-250 |
| **Variation in annual rainfall (%)** | 50-60 |
| **Average annual evaporation (mm/a)** | 3,200-3,400 |
| **Water deficit (mm/a)** | 2,100-2,300 |
| **Temperature (°C)** | 19-20 |

| Average Monthly Rainfall (mm) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Jul** | **Aug** | **Sep** | **Oct** | **Nov** | **Dec** | **Jan** | **Feb** | **Mar** | **Apr** | **May** | **Jun** |
| **0.3** | **0.8** | **1.7** | **8.5** | **12.0** | **15.7** | **43.4** | **51.8** | **39.7** | **20.9** | **3.9** | **1.8** |

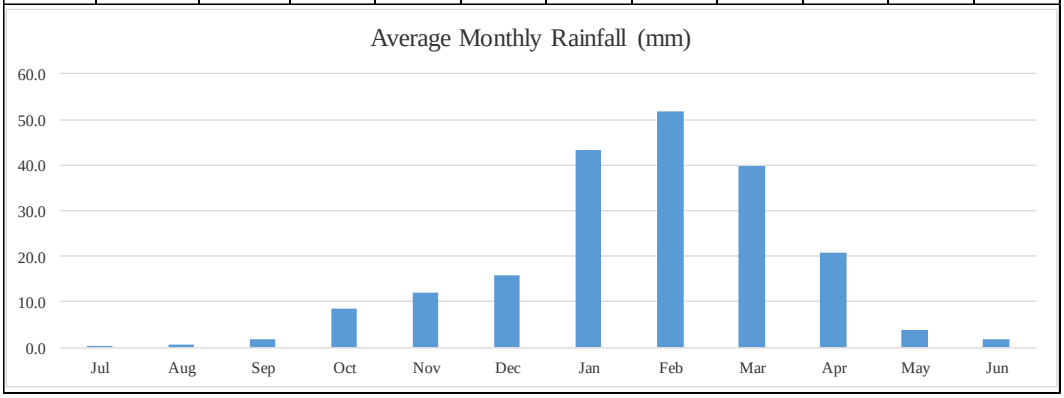



**Figure 3. Average monthly rainfall (Atlas of Namibia)**

### 4.3 TOPOGRAPHY & DRAINAGE

The general topography of the Stampriet Artesian aquifer's catchment can be described as relatively flat, with the elevation decreasing towards the southeast. The project area forms part of the Kalahari sandveld landscape The Kalahari sandveld is known for palaeo dunes and pans, which can clearly be seen in the larger study area. The farm is located on the flat area surrounding the Auob River with dunes located to the east and west of the farm. All the dunes in the area are parallel and strike north-northwest to east-southeast.

Drainage is poorly developed in the area. The site falls within the catchment of the Auob River, an ephemeral river, draining in a southern direction.

### 4.4 GEOLOGY AND HYDROGEOLOGY

The geology of the Stampriet artesian aquifer is underlain by the Damara Sequence, the Nama and Dwyka Groups, they serve as impermeable layers beneath the major water bearing layers (Auob and Nossob Members). The Damara Sequence consist of sedimentary and volcanic rocks which were deformed (folded and faulted), metamorphosed and intruded by granite during the Pan Africa Orogeny.

The geology of the Nama Group consist of layered sedimentary rocks, mostly sandstone and shale, which formed during the Cambrian Age in a marine environment. The Dwyka Group forms part of the Karoo Sequence and was formed during the late Permian and early

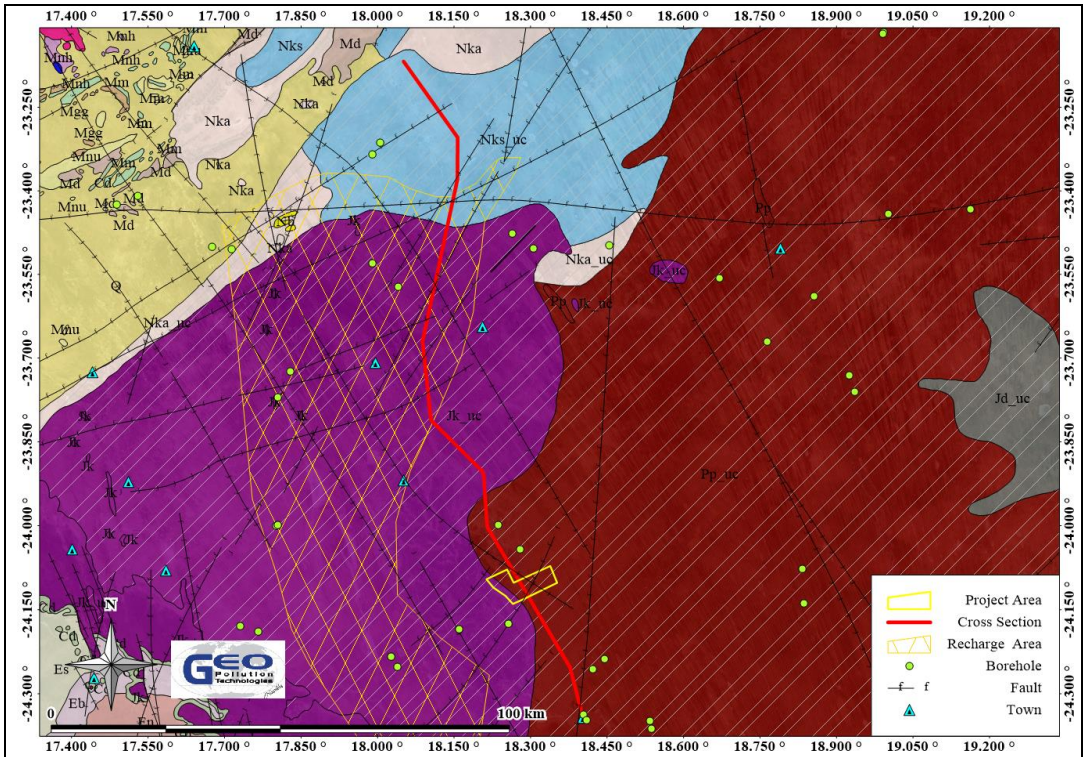
Carboniferous Age and consists of complex successions of tillite, glaciomarine mudstones with dropstones and minor glaciofluvial sandstones, all formed in a glacial environment.

The two major aquifer layers are the Auob and Nossob Members of the Prince Albert Formation, forming part of the Ecca Group of the Karoo Sequence. Both these Members consist of sedimentary rocks, mostly sandstones, with the Auob Member also containing layers of coal.

The Auob Member is the larger aquifer and it is shallow and high yielding. No direct recharge from precipitation occur to this aquifer. Indirect recharge do however occur in areas where the Kalahari aquifer overlay the Auob Member. Where the Rietmond Member separate these two layers, recharge is slow and a lot less (Peck, H., et.al. 2009). During episodic rainfall events some recharge occur into the Auob Member through karstic sinkholes located in calcrete of the Kalahari Formation on top of the Kalkrand basalts. This pan-line structures form a depression in the ground normally between 0.5 m and 1 m deep and have a diameter of 50 m to 100 m. The structures are formed by karsticfication in the Kalahari calcretes (Kirchner, J., et.al. 2002). These sinkholes and fractures are located along the rim of the basin. These structure are located northwest of Mariental up to Hoachanas and Duineveld. The Nossob Member is the inferior aquifer and is located below the Auob Member. No form of recharge is considered to occur in this member. The Nossob Member can be described as fossil water.

The surficial geology on site consist of soil forming part of the Kalahari Group which were deposited since the start of the Cenozoic era (66 Ma) up until today. The subsurface geology on the larger portion of the farm consist of shale and mudstone of the Prince Albert Formation. The Prince Albert Formation formed during the Permian Age and forms part of the Ecca Group in the Karoo Sequence. A small portion along the western border of the farm consist of basalt and minor sandstone of the Kalkrand Formation. This formation also formed during the Karoo Sequence, but formed during the younger Jurassic Age (Figure 4).

Figure 5 below depicts a geological cross section for the area. The extent of the cross section can be seen as the red line in Figure 4, starting north of Hoachanas and ending at Stampriet. The location of the farm can be seen in Figure 5 at the red arrow. In the figure the depth of each layer can be calculated as well as the geological sequence with depth. Farm Campbellsdrei will have a geological sequence with depth as follows: a layer of Kalahari sand and calcrete, Rietmond Member, Auob Member, Mukorob Member, Nossob Member and the deepest layer consist of pre-Ecca rocks. The Kalahari sands and clacretes are unconsolidated sands at the surface with some consolidation and cementation occurring with depth. The Rietmond Member consists mostly of shale and sandstones. The shale layers makes the Rietmond Member impervious and the main aquitard. The Auob Member consist of sandstones and is the main aquifer of the Stampriet Artesian Basin. The Mukorob Member consist of successions of shale, siltstone and sandstone. The layers of sandstone and siltstone where the shale is absent forms part of the aquifer. The shale layers are however impermeable and do not contain water. The Nossob Member also consist of sandstones and also forms a different lower yielding, deeper aquifer. Lastly the pre-Ecca rocks forms the basement of the aquifer and also serve as an impermeable layer. These rocks include sandstones and shales (JICA; 2002). Figure 6 depicts a general stratigraphic model of the Stampriet Artesian Basin.




| LITHCODE | AGE | SEQUENCE | GROUP | SUBGROUP | FORMATION | COMPLEX | INTRUSIVE_UNIT | SUITE | ROCKTYPES | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|
| Q | Quaternary | | | | | | | | Alluvium, sand, gravel, calcrete | |
| Tk | Quaternary and Tertiary | | Kalahari | | | | | | Sand, calcrete, gravel | |
| Jd_uc | Jurassic to Cretaceous | | | | | | | | Dolerite sills and dykes | Suboutcrop below Tk, Qn and other superficial deposits |
| Jk | Jurassic | Karoo | | | Kalkrand | | | | Basalt, minor sandstone | |
| Jk_uc | Jurassic | Karoo | | | Kalkrand | | | | Basalt, minor sandstone | Suboutcrop below Tk, Qn and other superficial deposits |
| Pp | Permian | Karoo | Ecca | | Prince Albert | | | | Shale, mudstone | |
| Pp_uc | Permian | Karoo | Ecca | | Prince Albert | | | | Shale, mudstone | Suboutcrop below Tk, Qn and other superficial deposits |
| Cd | Permo-Carboniferous | Karoo | Dwyka | | | | | | Tillite, boulder shale, shale, sandstone, limestone | |
| Eg | Cambrian | | Nama | Fish River | Gross Aub | | | | Red shale and sandstone | |
| En | Cambrian | | Nama | Fish River | Nababis | | | | Red sandstone and shale | |
| Eb | Cambrian | | Nama | Fish River | Breckhorn | | | | Red/grey sandstone and shale | |
| Es | Cambrian | | Nama | Fish River | Stockdale | | | | Red sandstone and shale | |
| Nks | Namibian | | Nama | Kuibis | | | | | Sandstone, black limestone, conglomerate, shale | |
| Nks_uc | Namibian | | Nama | Kuibis | | | | | Sandstone, black limestone, conglomerate, shale | Suboutcrop below Tk, Qn and other superficial deposits |
| Md | Namibian | | | | Doornpoort/Eskadron | | | | Quartzite, conglomerate, shale, basalt, rhyolite, ignimbrite | |
| Nmh | Namibian | Damara | Hakos | Vaalgras | Mahonda | | | | Quartzite, micaceous quartzite, mica schist | |
| Nb | Namibian | Damara | Nosib | | Blaubeker | | | | Mixtite | |
| Ndu | Namibian | Damara | Nosib | | Duruchaus | | | | Quartzite, conglomerate, schist, marble | |
| Nka | Namibian | Damara | Nosib | | Kamtsas | | | | Quartzite, conglomerate, schist, marble | |
| Nka_uc | Namibian | Damara | Nosib | | Kamtsas | | | | Quartzite, conglomerate, schist, marble | Suboutcrop below Tk, Qn and other superficial deposits |
| Me | Mokolian | | Khoabendus | | Elim | | | | Rhyolite, basalt, andesite, ortho-amphibolite, greenschist, quartzite, | |
| Mgg | Mokolian | Sinclair | | | Guperas | | | Gamsberg | Granite | |
| Mnu | Mokolian | Sinclair | | | Nuckopf | | | | Rhyolite, ignimbrite, conglomerate, quartzite, shale, basalt | |
| Mgp | Mokolian | | | | | | Piksteel Granodiorite | | Granodiorite | |
| Mho | Mokolian | | | | | Hohewarte | | | Para-/orthogneiss, metasedimentary rocks, granite, metabasite dykes | |
| Mka | Mokolian | | | | Klein Aub | | | | Quartzite, conglomerate, argillite | |
| Mm | Mokolian | Rehoboth | | | Marienhof | | | | Quartzite, phyllite, rhyolite, basalt, conglomerate, intrusive metabasite dykes | |
| Mmo | Mokolian | | | | | Mooirivier | | | Para-/orthogneiss, metasedimentary rocks, granite, metabasite dykes | |
| Mu | Mokolian | | | | | | | | Serpentinite, hornblendite, talc and chlorite schist | Related to Alberta/Doornboom Complexes |
| Mnh | Mokolian | | | | Neuhof | | | | Para-/orthogneiss, metasedimentary rocks, granite, metabasite dykes | |

**Figure 4. Hydrogeological map (after JICA; 2002)**

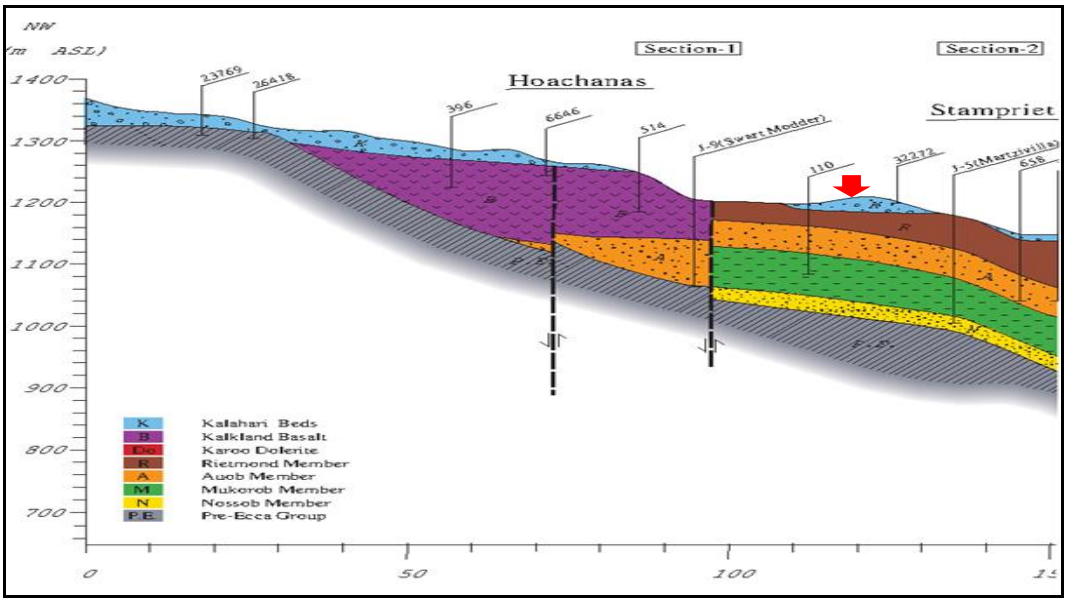



**Figure 5. Geological cross section (JICA; 2002)**

Groundwater flow is expected to take place through primary porosity in the surface cover, while it is expected to flow along fractures, faults, dykes/mineralised faults or along contact zones (secondary porosity) and other geological structures present within the underlying formations (hard rock formations).

Table 2 indicates the groundwater statistics for a radius of 5 km around the project area. The groundwater information was obtained from Department of Water Affairs (DWA) borehole database and from the proponent. The DWA database is generally outdated and more boreholes might be present. Groundwater is widely utilised in the study area, with a total of 18 boreholes within a 5 km radius. The boreholes were drilled to an average depth of 78 m below surface and yield between 1 and 40 m³/h. The groundwater quality falls under Group B with some boreholes having elevated levels of nitrates. The Group B category indicates that the water is of an acceptable quality, based on the provided parameters.

**Table 2. Groundwater statistics**

| Query Centre: | Campbellsdrei; -24.1158°S; 18.2809°E | | | | | | | | | Query Box Radius: 5.0km | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | NUMBER OF KNOWN BOREHOLES | LATITUDE | LONGITUDE | DEPTH (mbs) | YIELD (m3/h) | WATER LEVEL (mbs) | WATER STRIKE (mbs) | TDS (ppm) | SULPHATE (ppm) | NITRATE (ppm) | FLUORIDE (ppm) |
| Data points | 18 | | | 10 | 8 | 10 | 1 | 4 | 4 | 4 | 4 |
| Minimum | | -24.070804 | 18.231601 | 31 | 1 | 0 | 27 | 506 | 18 | 11 | 0 |
| Average | | | | 78 | 9 | 6 | 27 | 541 | 27 | 22 | 0 |
| Maximum | | -24.160796 | 18.330199 | 197 | 40 | 20 | 27 | 620 | 46 | 50 | 1 |
| Group A | | | | 20.00% | 12.50% | 80.00% | 0.00% | 100.00% | 100.00% | 0.00% | 100.00% |
| *Limit* | | | | 50 | >10 | 10 | 10 | 1000 | 200 | 10 | 1.5 |
| Group B | | | | 60.00% | 37.50% | 20.00% | 100.00% | 0.00% | 0.00% | 75.00% | 0.00% |
| *Limit* | | | | 100 | >5 | 50 | 50 | 1500 | 600 | 20 | 2.0 |
| Group C | | | | 20.00% | 50.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |
| *Limit* | | | | 200 | >0.5 | 100 | 100 | 2000 | 1200 | 40 | 3.0 |
| Group D | | | | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 25.00% | 0.00% |
| *Limit* | | | | >200 | <0.5 | >100 | >100 | >2000 | >1200 | >40 | >3 |

*Statistical grouping of parameters is for ease of interpretation, except for the grouping used for sulphate, nitrate and fluoride, which follow the Namibian guidelines for the evaluation of drinking-water quality for human consumption, with regard to chemical, physical and bacteriological quality. In this case the groupings has the following meaning:*
*Group A: Water with an excellent quality*
*Group B: Water with acceptable quality*
*Group C: Water with low health risk*
*Group D: Water with a high health risk, or water unsuitable for human consumption.*

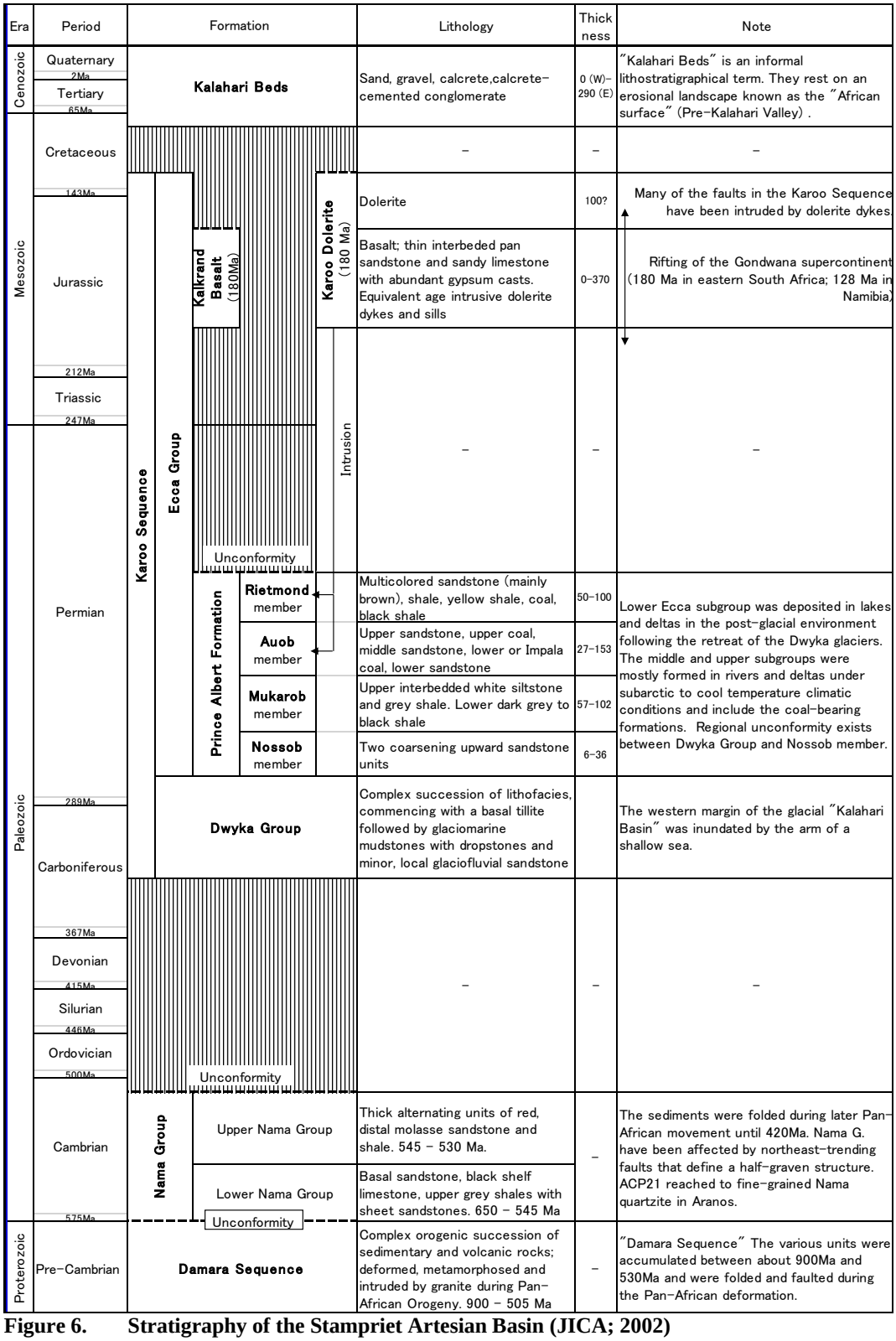



**Figure 6. Stratigraphy of the Stampriet Artesian Basin (JICA; 2002)**

According to the Ministry of Agriculture, Water and Forestry (MAWF; 2006) the farm is located inside the Windhoek-Gobabis-Mariental-Keetmanshoop Artesian Area - Government Notice 302 of 1 October 1955. Government regulates groundwater usage in this area and all other groundwater related activities like drilling, cleaning or deepening of boreholes and rates of water abstraction. See Figure 2 for a map indicating the water control area, groundwater basin and inferred groundwater flow. The site is located within the South Eastern Kalahari Groundwater Basin. Groundwater flow on site can be expected in a southeastern direction.

Groundwater quality data is presented in Figure 7 as a Maucha Plot. From the figure it is clear that the groundwater of the project location is mostly of a calcium-magnesium-bicarbonate water type which suggest the water is recently recharged and the typical type of water for a calcrete rich environment. Groundwater to the west of the site has higher concentrations of sodium (Na) and sulphates ($SO^{2-}_4$). This is caused by evaporation effects on top of the Kalkrand basalts that occur west of site. It should be noted that a number of rivers like the Skaap and the Oanib Rivers terminate in this area, presumably forming a pan similar to the Etosha Pan. The area was subsequently covered by Kalahari deposits, covering the evaporitic minerals on top of the Kalkrand basalt and possible by the dolerites of the Jurassic Age that occur southeast of site. The sodium bicarbonate water to the southeast is most probably due to salinization by dissolution.

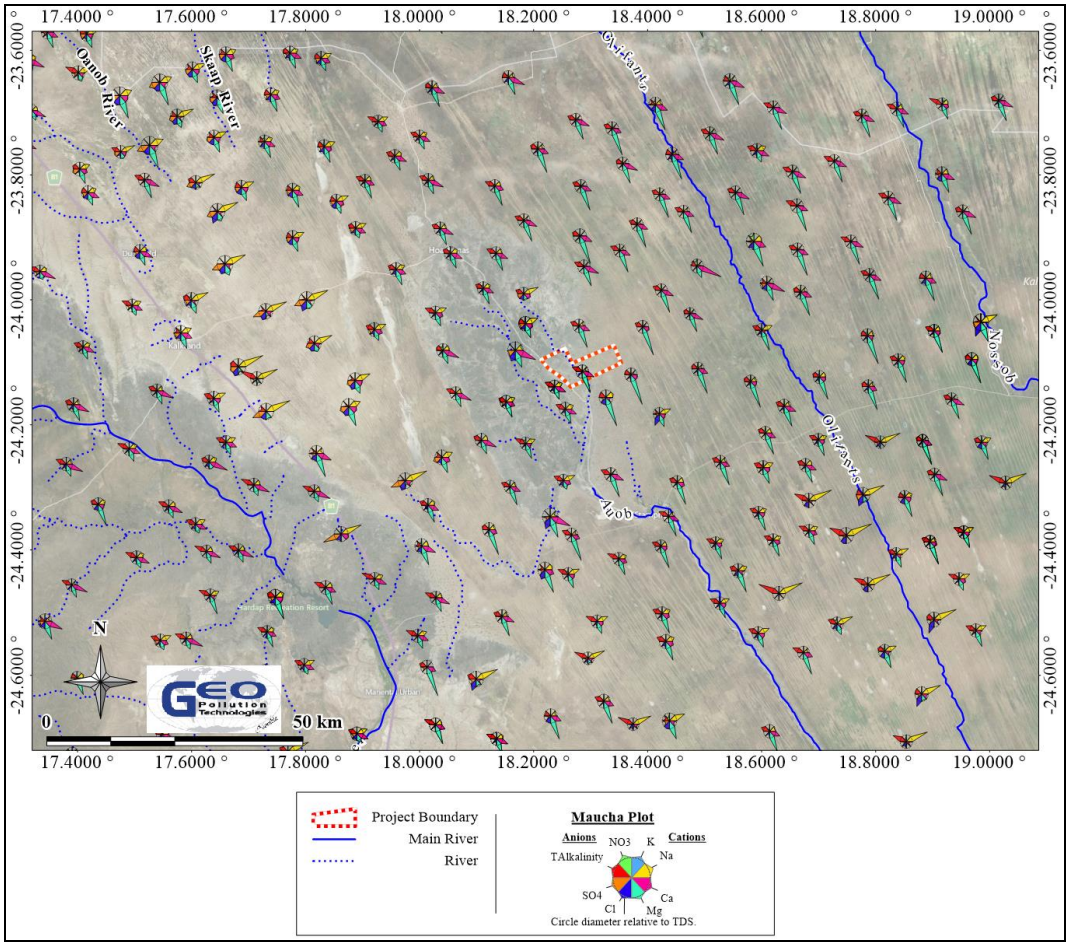



**Figure 7. Groundwater quality**

## 4.5 SOILS

The soils of the Kalahari Group can be classified as petric Calcisols for the larger area of the farm with only a small portion in the north-eastern corner comprising of eutric Leptosols. A Calcisol can be described as soil containing substantial secondary accumulation of lime that can vary in depth. These soils are common in arid and semi-arid environments and also in areas with a high calcareous parent geology. A petrocalcic horizon (petric) is a subsurface horizon which form when secondary carbonates, like calcium and others, accumulate in the subsoil to the extent that the soil becomes cemented. Leptosols can be described as very shallow soils over hard rock or normally calcareous rocks or deep soils containing a lot of stones and gravel. A eutric horizon can be identified as a soil having a base saturation of 50 % or more within 20 cm to 100 cm from the soil surface or within a layer at least 5 cm thick above a lithic contact in Leptosols. Figure 8 depict the surface geology as sand and calcrete.

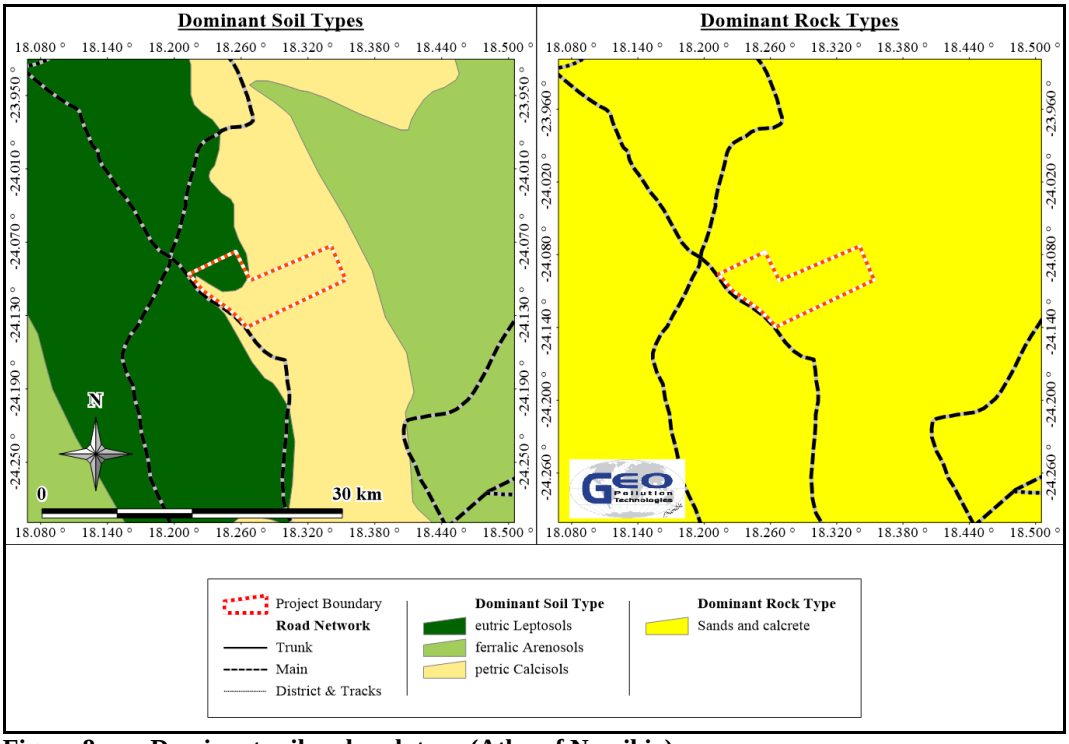



**Figure 8. Dominant soil and rock type (Atlas of Namibia)**

## 4.6 GROUNDWATER USAGE

From the site visit and data received from the client it is clear that six production boreholes are used on the farm for irrigation. These boreholes are installed with submersible pumps and is used to irrigate the lucerne fields via centre pivots and the citrus orchards via micro-sprayers.

The six boreholes were all drilled to replace old existing boreholes. One of the boreholes were drilled in 2017 namely WD 317009, the other five boreholes were drilled in 2018 namely WDR 180002, WDR 180004, WDR 18080012, WDR 18080013 and WDR 18080014. Table 3 below provides a summary of the boreholes. The location of these boreholes, as well as older boreholes, can be seen in Figure 9. Three of the boreholes (WDR 18080012, WDR 18080013 and WDR 18080014) are drilled close to each other near the main dwelling. WD 317009 and WDR 180002 are located north of the main dwelling, east of the river, approximately 700 m from each other. WDR 180004 is located 2.6 km northwest of the farmstead and closer to the river (Figure 9). The client obtained an abstraction permit in 2017 which are valid for 5 years, thus expiring 2022. The permit allows for the abstraction of 50,000 m³ per year (4,166.67 m³ per month).

**Table 3. Borehole information summary**

| Borehole Name | Depth (m) | Yield (m³/h) |
|---|---|---|
| WD 317009 | 100 | 120 |
| WDR 180002 | 100 | 200 |
| WDR 180004 | 95 | 200 |
| WDR 18080012 | 98 | >80 |
| WDR 18080013 | 97 | >80 |
| WDR 18080014 | 97 | >80 |

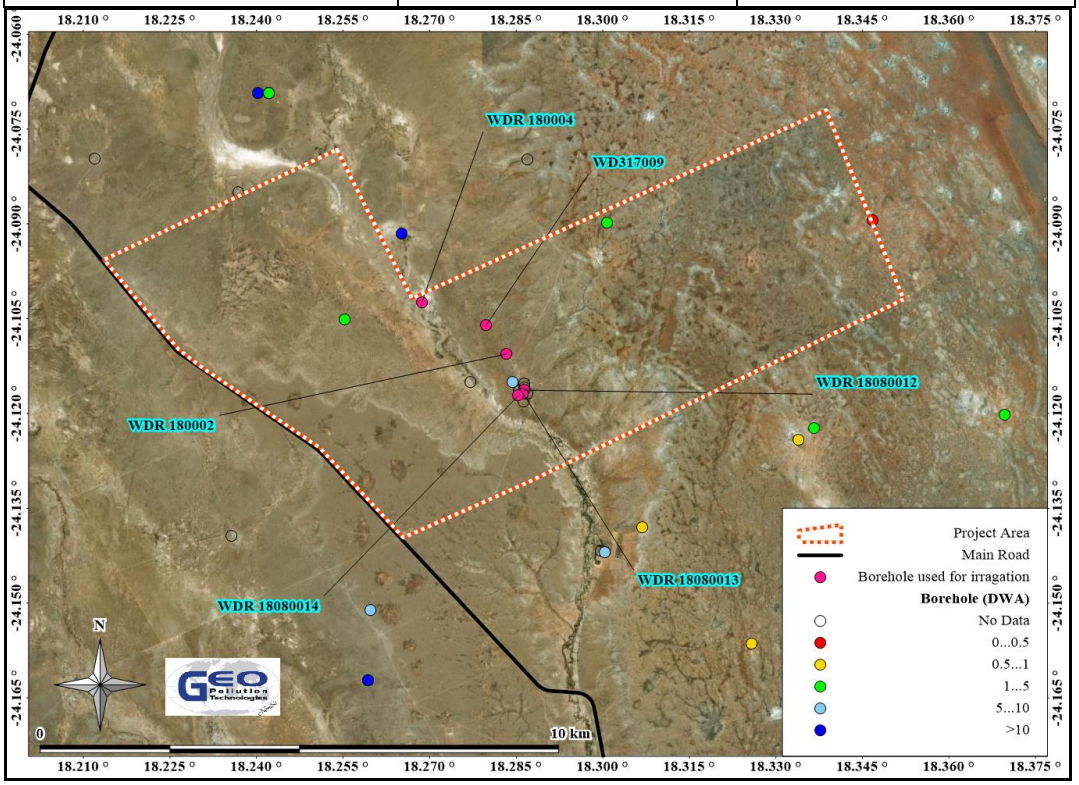



**Figure 9. Borehole locations**

# 5 ASSESSMENT OF BOREHOLE DATA

## 5.1 MONITOR BOREHOLE DATA

Regional water level monitoring data sourced from the DWA is presented in Figure 10. Historic rainfall data for the Bitterwasser weather station (NNDC Climate Data Online) and the Hardap weather station (NNDC Climate Data Online) are also presented. Data from the Bitterwasser station started in October 2008 and stopped in May 2009. The station remained offline until January 2013 when it started monitoring again and continued until March 2016, and has since not recorded again. The Hardap station started in December 2012 and continues up to today. There is thus a gap in rainfall data for the area (May 2009 to December 2012). The locations of the selected monitoring boreholes and weather stations are presented in Figure 12.

A linear profile of boreholes were selected to review the water level changes. The direction of the profile is in the same direction as the geological cross section seen in Figure 12. The following boreholes were selected WW21223, WW93562, WW8397, WW39857, WW40959, WW40960 and WW39854.

Borehole WW21223 is located just east of Windhoek in the Seeis area. This borehole is located 215 km northwest of the project area. WW 93562 is located approximately 45 km north of the site, not far from the Derm settlement. WW8397 is located 16 km northwest of the project area. Borehole WW39857 is located 10 km north of the site and is the closest monitoring borehole. WW40959 is located in Stampriet, 26 km southeast of the site. Borehole WW40960 is located approximately 60 km southeast of the site and lastly borehole WW39854 is located 200 km southeast of the site.

Borehole WW21223 located near Seeis is situated in a different aquifer. Water level monitoring in this borehole started December 2011 and ended March 2018. The historic water level in the borehole ranges between 2 m to 5 m below surface. The data has a saw tooth profile, with rapid increase of the water level and steady decrease due to abstraction. Boreholes in the Seeis area are drilled around the river and rely on the primary porosity from the sands in the river. The rapid increase of water levels will most likely be due to the river flowing in the rainy season.

Water level monitoring WW 93562, located near Derm, has data from November 2007 to July 2008. During the short period no real changes were noted in the water level of this borehole. The average water level monitored during that timeframe was 0.02 m, just below the surface.

WW8397 has data available from July 2008 to September 2016. The data from the borehole has a saw tooth profile, with rapid increases and decreases. The blocky steps in the data is most like due to human error, where the logger was not correctly installed, as natural increases or decreases in borehole water levels are usually a smooth curve. If the steps are ignored in the graph, it seems as if the borehole has a constant rest water level at 5 m below surface.

Borehole WW39857 is the nearest borehole to the site (10 km north of site) and will roughly represent water level changes similar to the project area. Data for this borehole starts in August 2008 and continue up to October 2018. During this time, some gaps in data occur and a major increase of water level were noticed from November 2013 to July 2014, this could be due to the high rainfall received in this time period as recorded at the Hardap weather station, or human error. All other data present a very slight sinusoidal effect, but no major increases or decreases are noted. The water level seems to fluctuate around 5 m below surface.

WW40959 located in Stampriet has data available from April 2010 to January 2018. A data gap occurs from July 2010 to October 2013. The data has a definite saw tooth profile, the minimum water level measured was 0.1 m below surface (March 2016), just after a good rainy season as recorded by both weather stations. The maximum water level was recorded at 4.3 m below surface in August 2017. Although the data has a saw tooth profile, a slight decrease in water level over the time period can be noticed.

WW40960 has data available from August 2008 to October 2018. Water levels stayed constantly at 36 m below surface, then a rapid step occurred in February 2018, that caused the water level to increase to 29 m below surface where it remained. The step in data is most likely due to human error or a fault on the logger.

WW39854 is located the furthest southeast of the site. Data for this borehole is available from August 2008 to September 2016. Some small data gaps occur in this time period. A major increase was noticed from March 2013 to July 2013, most likely due to human or instrumental error. If this step is ignored it seems that the water level in this borehole stays constant at 61 m below surface with no decrease noticed over the monitoring period.

Figure 11 below depict the regional water level profile of all the monitoring boreholes discussed above. In the figure, the minimum water level, the maximum water level, the average water level and the ground elevation at each borehole location can be seen. Across the profiles in Figure 11 and Figure 13 it can be seen that the elevation decrease from the northwest to the southeast, but the water levels in the boreholes are however deeper. Normally, at a lower elevation you tend to have a shallower water level. This deep water level at a low elevation is due to the depth of the water bearing Auob Member that increase with depth to the southeast and due to the thickness of the Kalahari Group that also increases to the southeast.

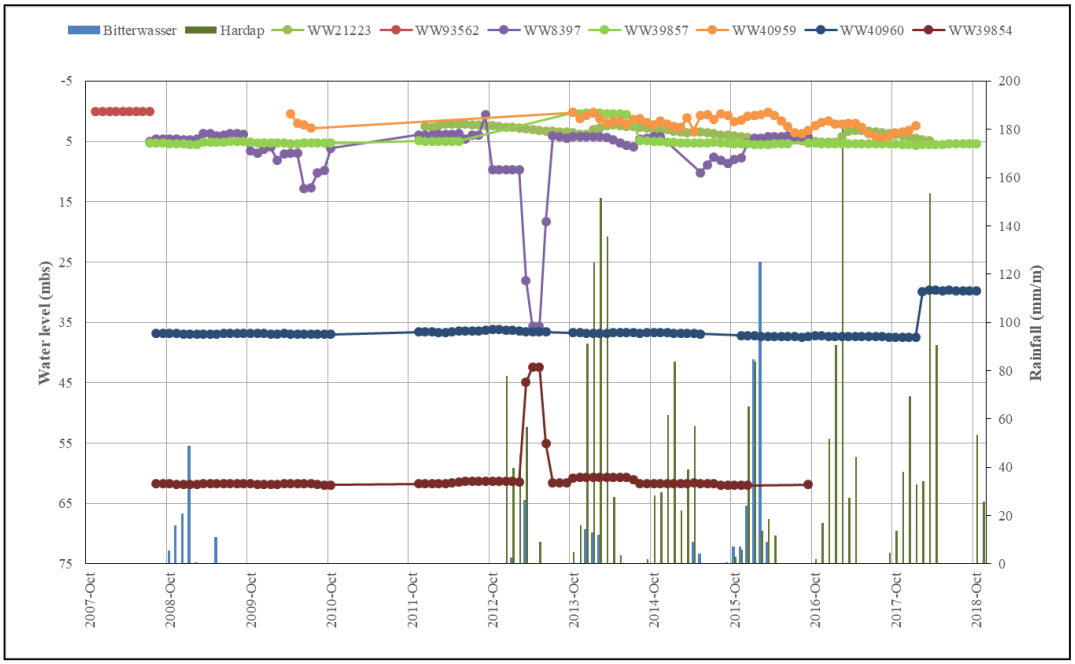



**Figure 10. Regional water level changes and monthly rainfall (MAWF; 2019)**

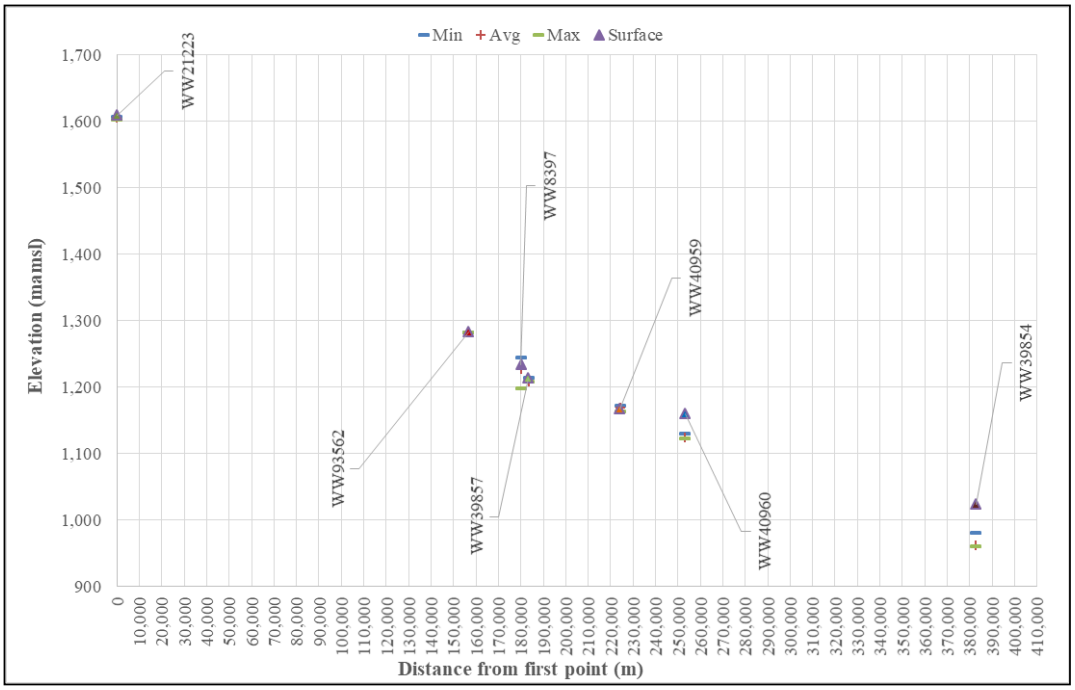



**Figure 11. Regional water level profile**

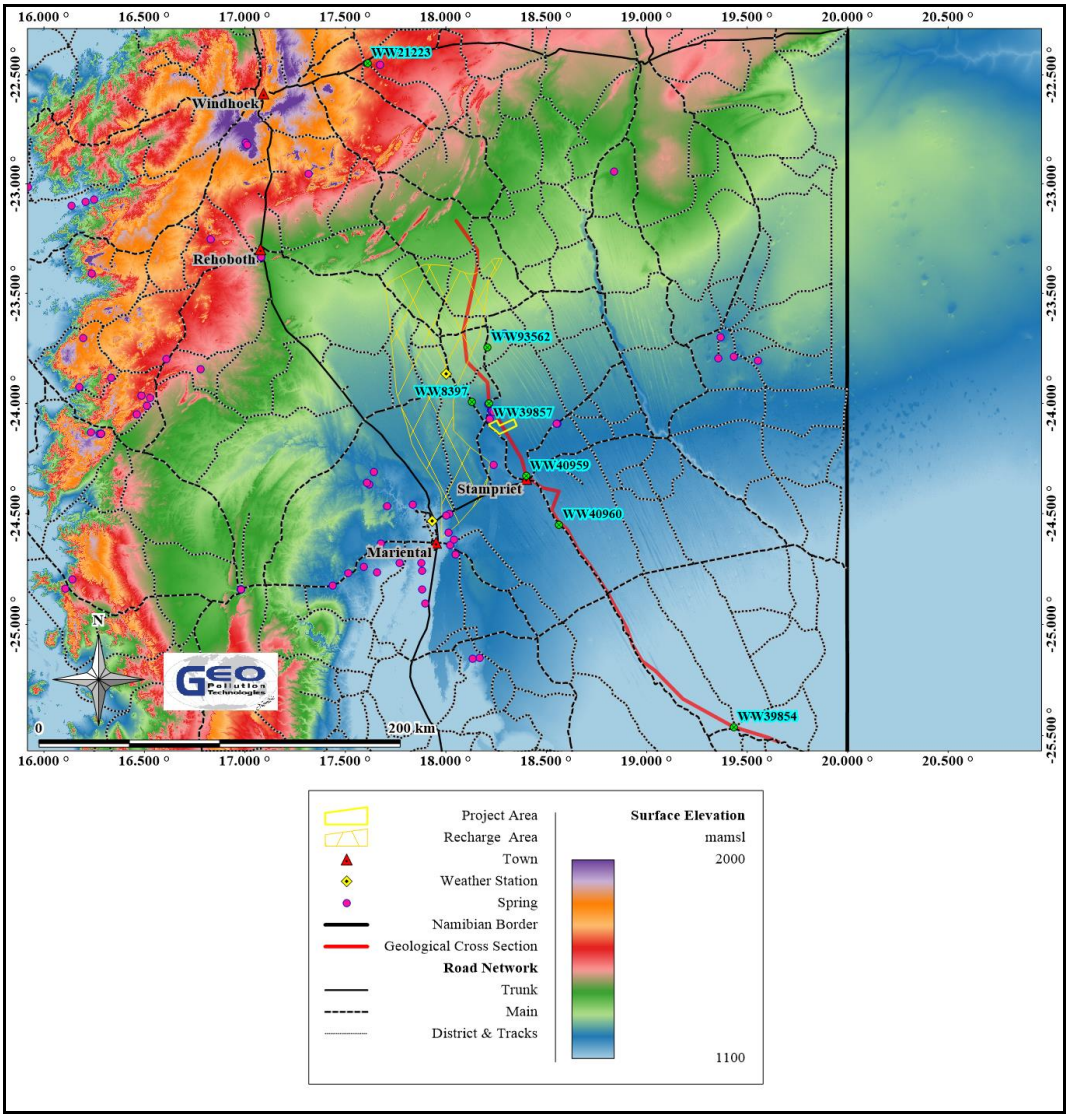



**Figure 12. Monitoring borehole, geological section springs and elevation**

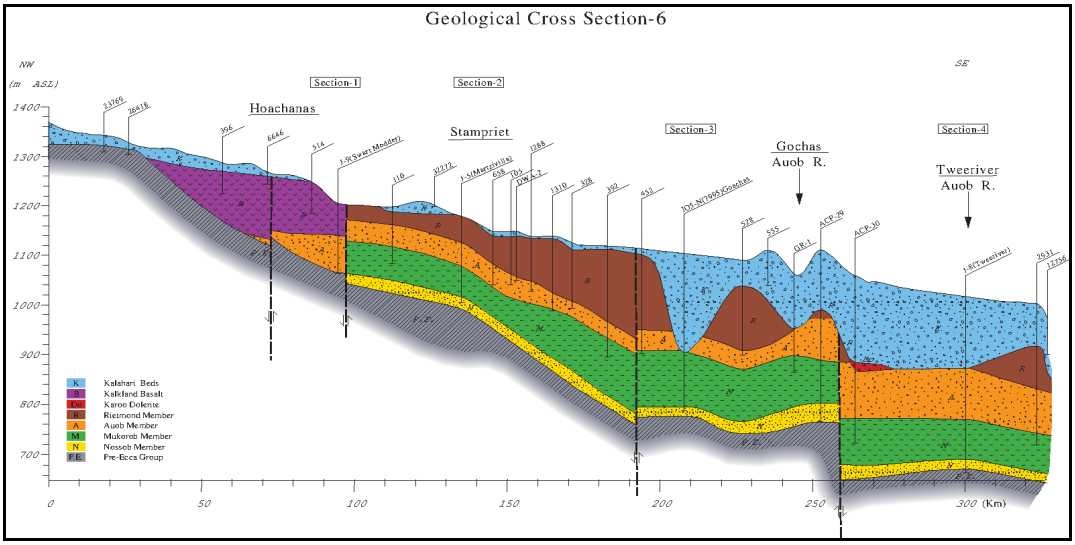



**Figure 13. Geological cross section over water level monitoring station (JICA; 2002)**

# 6 WATER SUITABILITY FOR IRRIGATION PURPOSES

Two water samples were collected by the farmer in July 2019, named Land 1 and Land 2, and were submitted for quality analysis. Figure 14 below presents the analysis as a Piper diagram. From the graph it is evident that the water from the two different sources are very similar in chemical composition, with only a difference in the concentrations of calcium, sodium and potassium. The sample named Land 1 has higher concentrations of sodium and potassium and lower concentration of calcium. The sample named Land 2 on the other hand, has higher concentration of calcium and lower concentrations of sodium and potassium. This minor difference in chemical composition causes the samples to be described as two different types of water. Water from Land 1 can be described as sodium bicarbonate water and more in the mixing zone as elements are still busy exchanging. Water from Land 2 can be described as calcium bicarbonate water, which is water with temporary hardness.

Calculations based on the analysis results indicate that the sample can be classified as having a high salinity hazard (C3), a low sodium hazard (S1), a bad Permeability Index (injurious to plants) and an unsuitable Magnesium Adsorption Ratio (MAR), see Figure 15.

High-salinity water (C3) cannot be used on soils with restricted drainage. This is due to salt accumulation in the crop root zone, reducing the amount of water available to the roots. Even with adequate drainage, special management for salinity control may be required and plants with good salt tolerance should be selected. Reduced crop growth and yield can be expected.

Low sodium water (S1) can be used for irrigation on almost all soils with little danger of the development of harmful levels of exchangeable sodium.

The Permeability Index of soil is affected by irrigation water with high sodium, calcium, magnesium and bicarbonate content, coupled to its long term use. High sodium in the irrigation water can cause soil permeability problems. Permeability is also affected by $CO_3^{2-}$ and $HCO_3^-$ concentrations in the water. A portion of $CO_3^{2-}$ and $HCO_3^-$ is precipitated as $CaCO_3$ (or) $MgCO_3$ removing Ca and Mg from irrigation water and leads to increased precipitation of these elements.

Magnesium is essential for plant growth, but too much magnesium can have a severe toxicity effect on plants. A Magnesium Adsorption Ratio exceeding 50 is considered unsuitable for plants as it may increase the salinity of soil.

Care must be exercised when long term irrigation takes place on unsuitable soil.

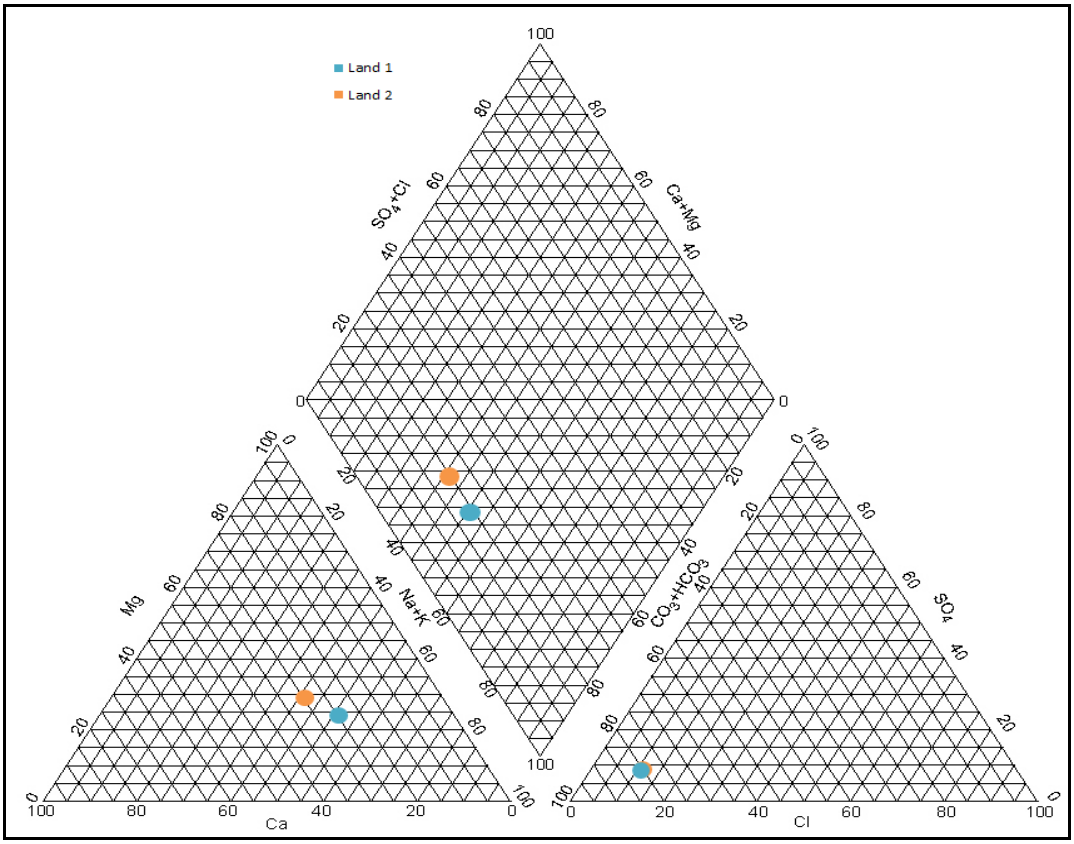
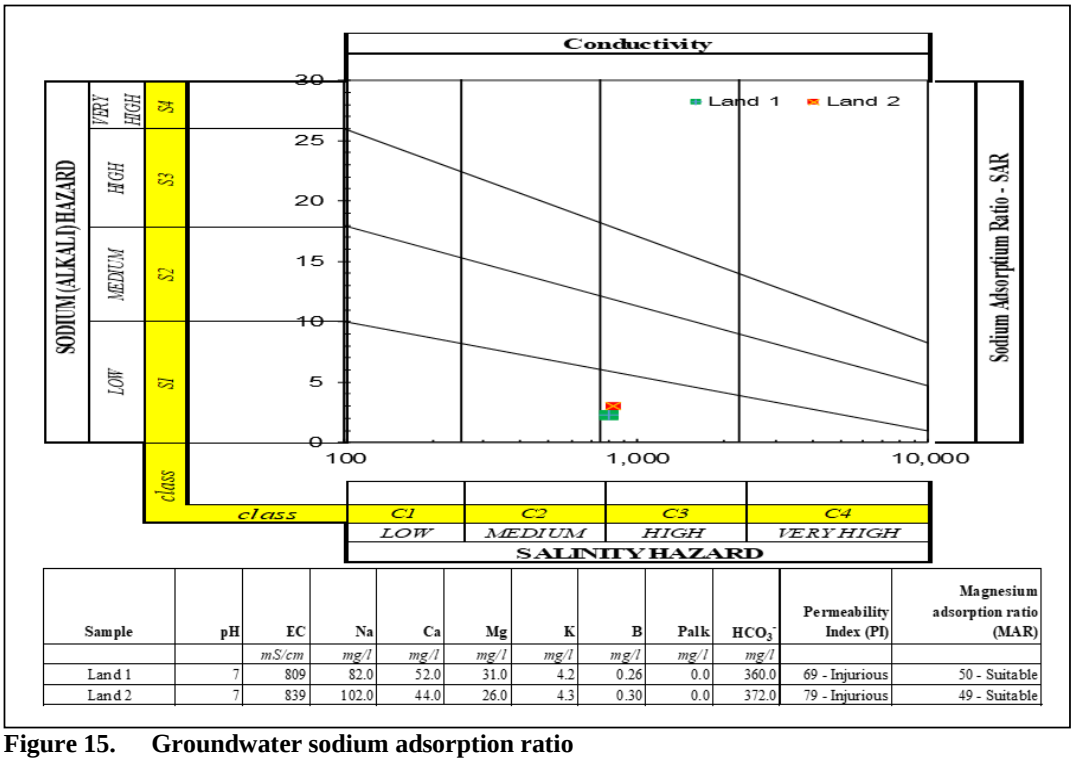



**Figure 14. Piper diagram for irrigation water**




| Sample | pH | EC | Na | Ca | Mg | K | B | Palk | $HCO_3^-$ | Permeability Index (PI) | Magnesium adsorption ratio (MAR) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *mS/cm* | *mg/l* | *mg/l* | *mg/l* | *mg/l* | *mg/l* | *mg/l* | *mg/l* | | |
| Land 1 | 7 | 809 | 82.0 | 52.0 | 31.0 | 4.2 | 0.26 | 0.0 | 360.0 | 69 - Injurious | 50 - Suitable |
| Land 2 | 7 | 839 | 102.0 | 44.0 | 26.0 | 4.3 | 0.30 | 0.0 | 372.0 | 79 - Injurious | 49 - Suitable |

**Figure 15. Groundwater sodium adsorption ratio**

# 7 SOIL SUITABILITY FOR IRRIGATION PURPOSES

Twenty (20) soil samples were collected during July 2019 on farm Campbellsdrei and were analysed at a laboratory. Chemical analysis and sieve analysis were performed. The exact locations of the sampling points are unknown, but the results give a general idea of the soil type and quality for the farm. The soil had a pH value ranging between 7.9 and 9.1. The soil can be described as alkaline soil. The high pH range can cause deficiency of nitrogen, phosphorus and micro elements such as iron, manganese, boron, copper and zinc. Figure 16 below indicate the solubility of elements at different pH levels, the red square represents the pH levels present in the farm soil.

A summary of the soil sample results are depicted in Table 4. All elements highlighted in blue in Table 4 has low concentrations of the elements as required by plants. All highlighted in orange has high concentrations of the elements that can be harmful to plants. All the elements highlighted in white is in the most efficient range as required by plants. The pH of the soil is slightly high for crop production, this can be expected in a calcrete rich environment, as calcretes have acid buffering properties and therefore elevate soil pH, making the soil more alkaline. All the soil have deficient organic carbon and organic matter. When laboratories analyse for organic matter it includes hydrogen, oxygen, nitrogen and other elements that are components of organic compounds, not just carbon. In contrast, total organic carbon is a measure of only the carbon contained within soil organic matter. Some of the samples have insufficient concentrations of phosphorus, potassium and calcium. Magnesium concentration are however very high and can be harmful to the plants.

Sieve analysis were conducted on the 20 samples. The purpose of the sieve analysis is to determine the grain size of the soil and to determine what percentage of the soil comprise of sand, clay and silt. Knowing these physical properties of the soil enables one to calculate the amount of water the plants will need. As a sandy soil will have a much faster infiltration rate and be well drained, where as a clay rich soil will have a higher water retention rate and will stay moist for longer. All the samples plotted in the bottom left corner of the soil texture triangle (Figure 17), which means it is a sand rich soil with very small amounts of clay and silt. The soil will be well drained and require more watering of plants.

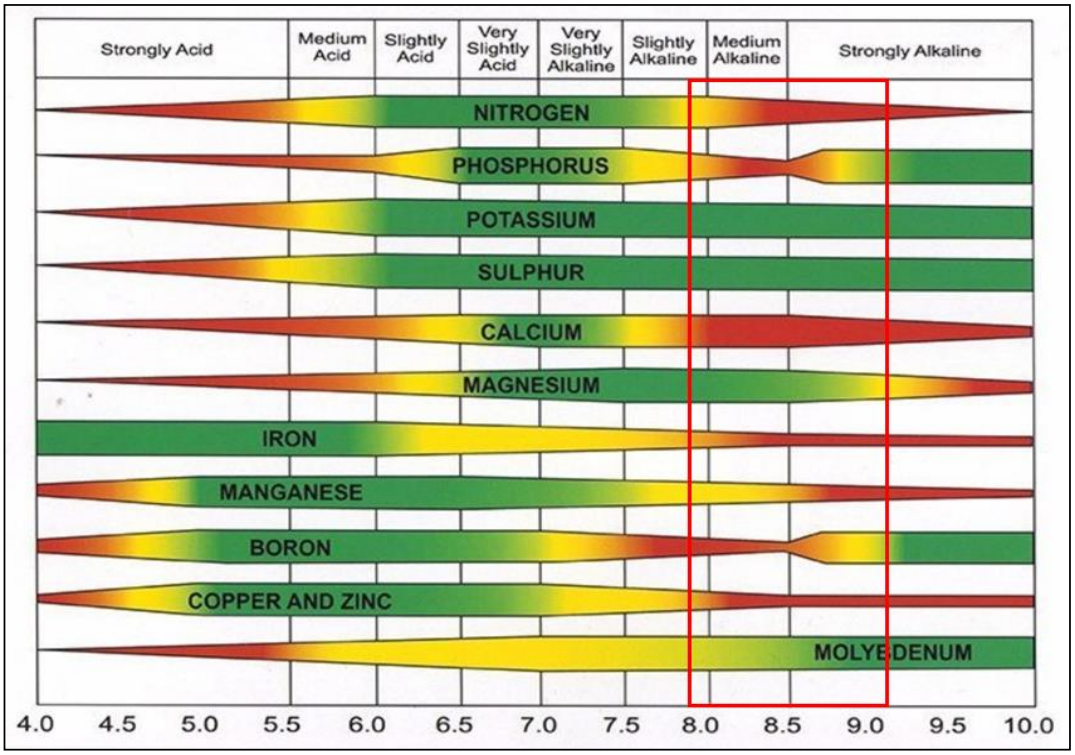



**Figure 16. Soil pH effects on availability of elements (after University of California; 2019)**

**Table 4. Soil sample results**

| Type of Test: | | pH (H2O) | Organic carbon | Organic matter | Phosphorus | Potassium | Magnesium | Calcium |
|---|---|---|---|---|---|---|---|---|
| *Method details:* | | *electrometric* | *Walkey Black* | *factor = 1.724* | *Ohlsen* | | | |
| Lab No. | Sample Refrence | | *% m/m C* | *% m/m OM* | *mg P /kg* | *mg K/kg* | *mg Mg/kg* | *mg Ca/kg* |
| 1 | Land 1, Block 1, oos | 8.9 | 0.31 | 0.54 | 8.77 | 74.6 | 266.06 | 1997.85 |
| 2 | Land 1, Block 1, wes | 9.1 | 0.12 | 0.20 | 1.16 | 75.04 | 214.86 | 762.95 |
| 3 | Land 1, Block 2, oos | 8.2 | 0.24 | 0.42 | 11.84 | 200.6 | 173.76 | 1197.85 |
| 4 | Land 1, Block 2, wes | 8.8 | 0.39 | 0.67 | 5.62 | 73.83 | 295.96 | 1744.85 |
| 5 | Land 1, Block 3, oos | 9.1 | 0.18 | 0.31 | 4.10 | 102.2 | 202.46 | 587.45 |
| 6 | Land 1, Block 3, wes | 8.8 | 0.44 | 0.75 | 11.45 | 87.52 | 269.66 | 1650.85 |
| 7 | Land 1, Block 4, oos | 8.8 | 0.23 | 0.39 | 7.34 | 69.55 | 224.76 | 1266.85 |
| 8 | Land 1, Block 4, wes | 8.8 | 0.07 | 0.12 | 4.76 | 63.97 | 162.16 | 507.45 |
| 9 | Land 1, Block 5, oos | 8.6 | 0.04 | 0.07 | 7.05 | 84.81 | 296.36 | 655.55 |
| 10 | Land 1, Block 5, wes | 8.9 | 0.12 | 0.22 | 6.00 | 68.42 | 194.96 | 817.65 |
| 11 | Land 1, Block 6, oos | 7.9 | 0.47 | 0.81 | 9.63 | 100.7 | 278.56 | 943.25 |
| 12 | Land 1, Block 6, wes | 9 | 0.12 | 0.20 | 1.73 | 88.99 | 234.46 | 761.55 |
| 13 | Land 2, Block 1, oos/noord | 9 | 0.12 | 0.20 | 6.00 | 162.5 | 134.46 | 1247.85 |
| 14 | Land 2, Block 1, wes | 9 | 0.23 | 0.39 | 8.96 | 268.9 | 176.26 | 1981.85 |
| 15 | Land 2, Block 2, oos | 8 | 0.20 | 0.34 | 7.05 | 259.3 | 192.76 | 1907.85 |
| 16 | Land 2, Block 2, wes | 9.1 | 0.38 | 0.66 | 7.15 | 160.4 | 172.76 | 3358.85 |
| 17 | Land 2, Block 3, oos | 9 | 0.28 | 0.48 | 7.91 | 146.6 | 81.94 | 1497.85 |
| 18 | Land 2, Block 3, wes | 9 | 0.30 | 0.51 | 8.48 | 187.1 | 172.56 | 2856.85 |
| 19 | Land 2, Block 4, oos | 9.1 | 0.29 | 0.50 | 9.06 | 199.8 | 197.76 | 3164.85 |
| 20 | Land 2, Block 4, wes | 8.9 | 0.30 | 0.52 | 9.73 | 175 | 168.16 | 2610.85 |

| | Low | Meduim | High |
|---|---|---|---|
| pH | 5.4 | 5.5 - 6.7 | 6.8 |
| Organic Carbon | <0.9% | 0.9% - 1.3% | >1.3% |
| Phosphorus | <10 | 10 mg/kg - 20 mg/kg | 20 mg/kg - 40 mg/kg |
| K | <150 mg/kg | 150 mg/kg - 250 mg/kg | >250 mg/kg |
| Mg | <60 mg/kg | 60 mg/kg - 180 mg/kg | >180 mg/kg |
| Ca | <1000 mg/kg | 1000 mg/kg - 2000mg/kg | >2000mg/kg |

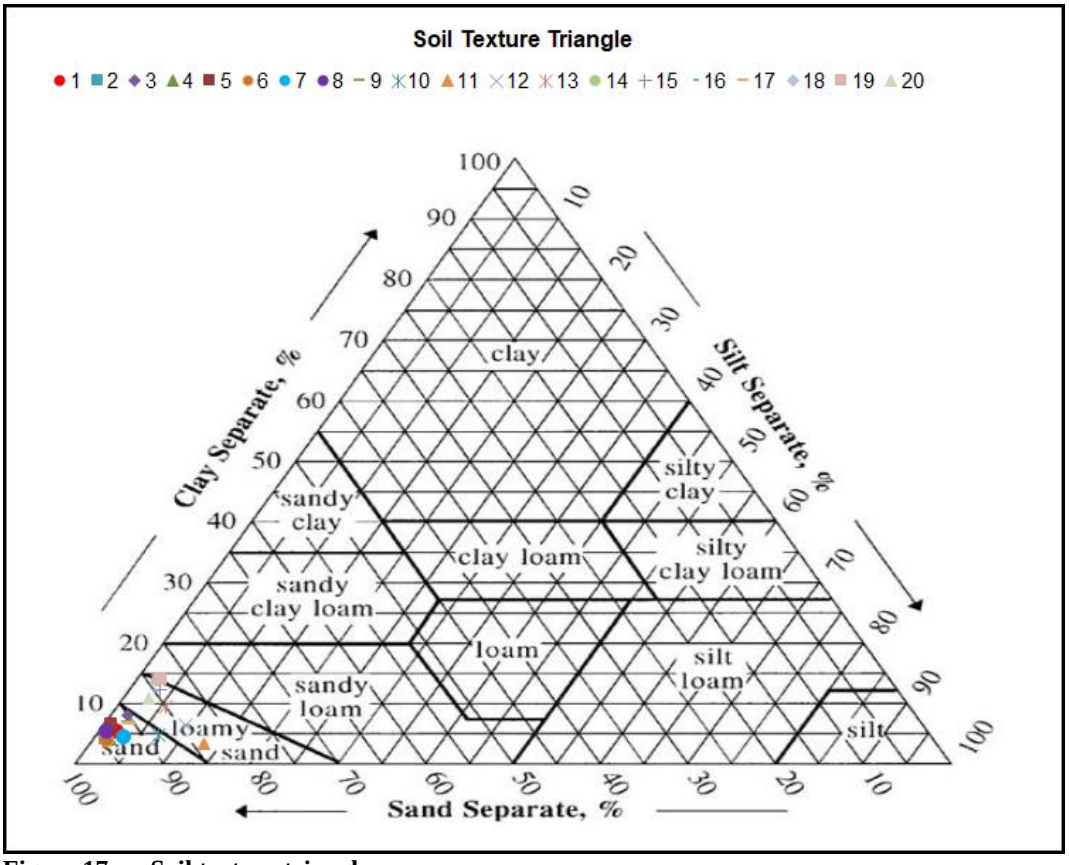



**Figure 17. Soil texture triangle**

# 8 ASSESSMENT OF IMPACTS

The purpose of this section is to assess and identify the most pertinent environmental impacts and provide possible mitigation measures that are expected from the project. The Rapid Impact Assessment Method (Pastakia, 1998) will be used during the assessment. The Environmental Classification of impacts is provided in Table 5.

Impacts are assessed according to the following categories: Importance of condition (A1); Magnitude of Change (A2); Permanence (B1); Reversibility (B2); and Cumulative Nature (B3) (see Table 6).

Environmental Classification = A1 x A2 x (B1 + B2 + B3)

The probability ranking refers to the probability that a specific impact will happen following a risk event. These can be improbable (low likelihood); probable (distinct possibility); highly probable (most likely); and definite (impact will occur regardless of prevention measures). See Table 7 and Table 8 for the final assessment of expected impacts.

**Table 5. Environmental classification of impacts according to the rapid impact assessment method of Pastakia 1998.**

| Environmental Classification (ES) | Class Value | Description of Class |
|---|---|---|
| 72 to 108 | 5 | Extremely positive impact |
| 36 to 71 | 4 | Significantly positive impact |
| 19 to 35 | 3 | Moderately positive impact |
| 10 to 18 | 2 | Less positive impact |
| 1 to 9 | 1 | Reduced positive impact |
| 0 | -0 | No alteration |
| -1 to -9 | -1 | Reduced negative impact |
| -10 to -18 | -2 | Less negative impact |
| -19 to -35 | -3 | Moderately negative impact |
| -36 to -71 | -4 | Significantly negative impact |
| -72 to -108 | -5 | Extremely Negative Impact |

**Table 6. Assessment criteria**

| Criteria | Score |
|---|---|
| **Importance of condition (A1) – assessed against the spatial boundaries of human interest it will affect** | |
| Importance to national/international interest | 4 |
| Important to regional/national interest | 3 |
| Important to areas immediately outside the local condition | 2 |
| Important only to the local condition | 1 |
| No importance | 0 |
| **Magnitude of change/effect (A2) – measure of scale in terms of benefit / detriment of an impact or condition** | |
| Major positive benefit | 3 |
| Significant improvement in status quo | 2 |
| Improvement in status quo | 1 |
| No change in status quo | 0 |
| Negative change in status quo | -1 |
| Significant negative detriment or change | -2 |
| Major detriment or change | -3 |
| **Permanence (B1) – defines whether the condition is permanent or temporary** | |
| No change/Not applicable | 1 |
| Temporary | 2 |
| Permanent | 3 |
| **Reversibility (B2) – defines whether the condition can be changed and is a measure of the control over the condition** | |
| No change/Not applicable | 1 |
| Reversible | 2 |
| Irreversible | 3 |
| **Cumulative (B3) – reflects whether the effect will be a single direct impact or will include cumulative impacts over time, or synergistic effect with other conditions. It is a means of judging the sustainability of the condition – not to be confused with the permanence criterion.** | |
| Light or No Cumulative Character/Not applicable | 1 |
| Moderate Cumulative Character | 2 |
| Strong Cumulative Character | 3 |

## 8.1 GROUNDWATER ABSTRACTION

Groundwater abstraction is a very sensitive topic in a dry country where the value of land is drastically reduced if no or unusable groundwater is present on the land. Abstraction of groundwater must be conducted in a sensible way to prevent impacts on other groundwater users that depend on such groundwater. This includes water abstracted for human and animal use, irrigation, and also ecosystems that depend on groundwater.

A typical model of an artesian aquifer was compiled to illustrate the layering of the confined aquifer between two impermeable layers, see Figure 18. Recharge occur on the rim of the catchment where the aquifer layer meets the surface or a permeable layer in which recharge occur. Recharge of the Auob aquifer is considered to be very low.

In a typical groundwater environment, a water balance would consist of inflow and outflow of the groundwater system (Figure 19). Over time an equilibrium (or steady state) is normally reached with rising water table following good recharge events and declining water table when recharge is below average. Inflow into the system would typically be from infiltration following rainfall in the recharge area and in upstream areas.

Outflow would be comprised of water leaving the system through springs and as outflow over the lower boundary of the groundwater system as well as evapotranspiration losses. Groundwater abstraction through boreholes is important as this is normally necessary to sustain human and animal demands where such users became dependant on the abstracted groundwater.

Typical consequences of over abstraction will include a lowering in the water table. Lowering of water table may further lead to the drying up of boreholes and springs. Vegetation will also be impacted where such vegetation has access to groundwater. Figure 19 below depict a conceptual model of Auob aquifer system. This figure indicates the areas of major abstraction, recharge area, different geological units and groundwater flow and flux out of the country. Important to note that the Auob aquifer is a transboundary aquifer that extent from Namibia into South Africa and Botswana, see Figure 20. Over abstraction in any of the countries will have a negative impact on the other countries and can causes disputes. As the groundwater flows from the recharge area in Namibia, out to the other two countries, care must be taken in Namibia to ensure that the quality of water is not affected as this will later on affect the other two neighbouring countries.

Based on current water level fluctuations in the area, as presented in and Figure 10, a short term threshold of 10 m below the average water level of each borehole is set from where abstraction rates should be reduced. The threshold is based on the data of WW39857, the closest borehole to site. The borehole data indicate some minor fluctuations over the period and an irregular step in the data. With all of this included, the water level still only ranged between 0.189 m to 5.59 m below surface. Thus 10 m below the average water level of each borehole is set as a threshold.

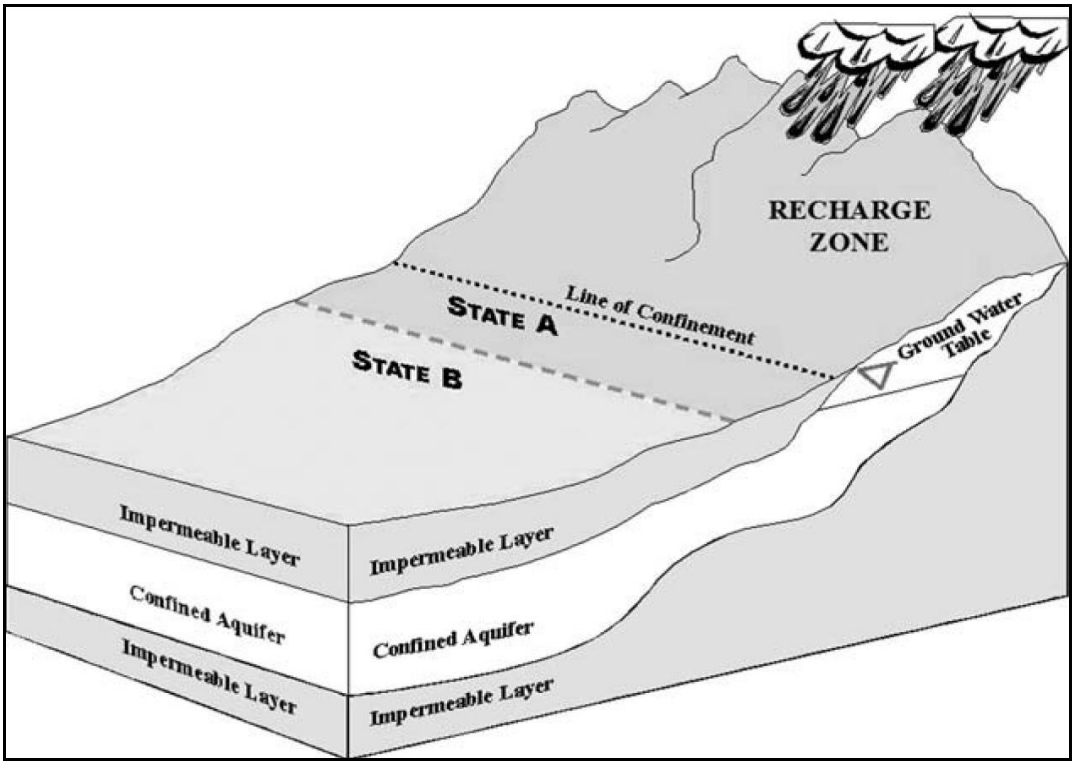



**Figure 18. Conceptual model of an artesian aquifer. (Peck, H. 2009)**

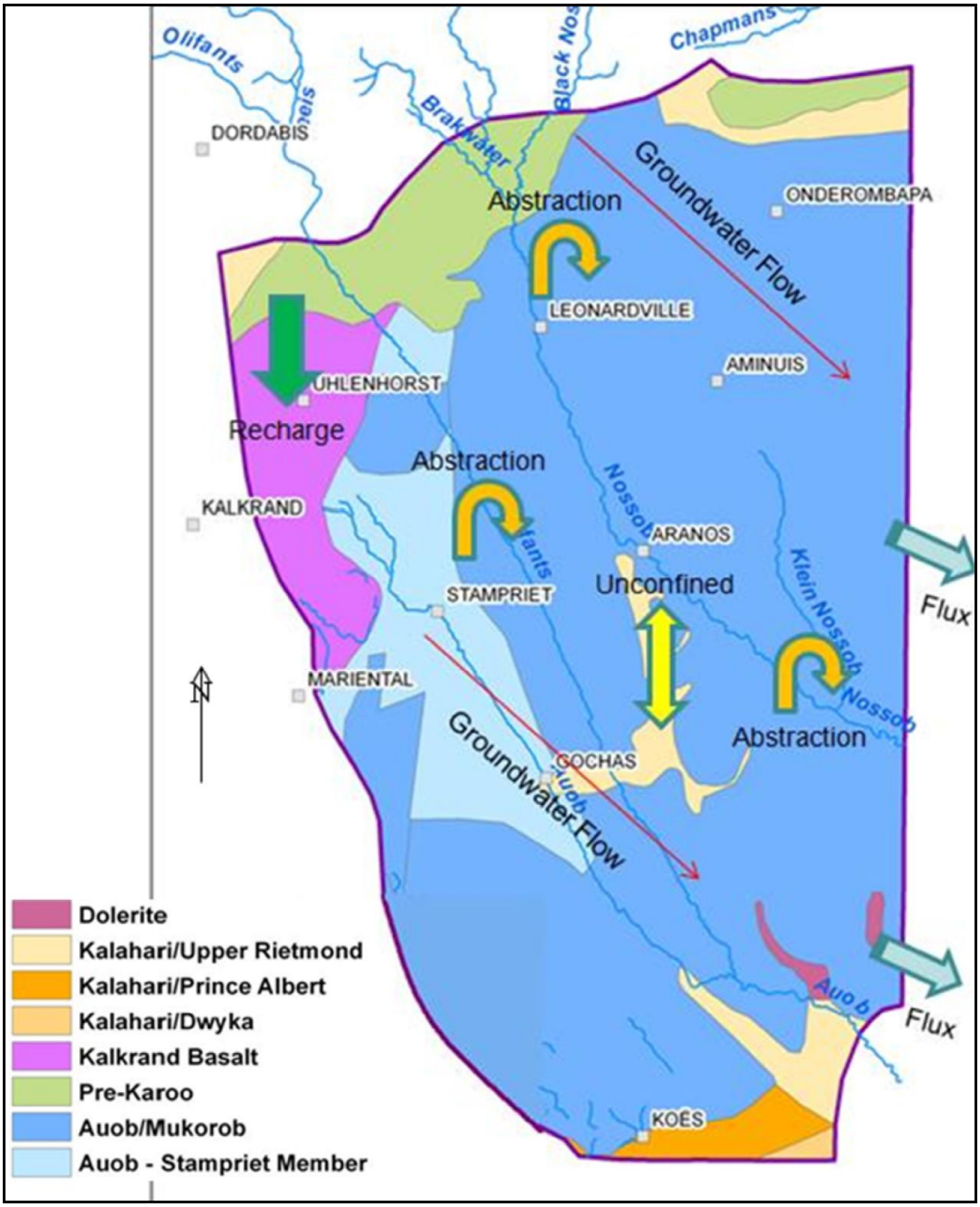



**Figure 19. Conceptual model of Auob aquifer system (Peck, H. 2009)**

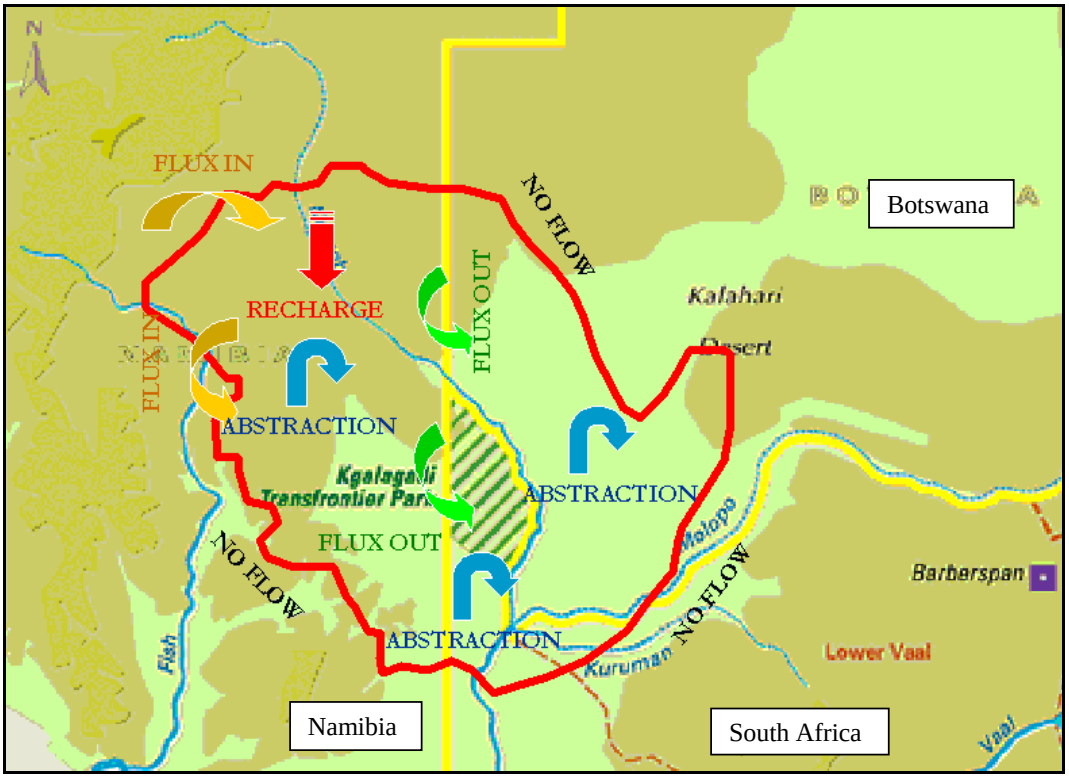



**Figure 20. Conception model of the Auob aquifer extent (Peck, H. 2009)**

**Table 7. Assessment – Groundwater abstraction**

| Project Activity / Resource | Nature (Status) | (A1) Importance | (A2) Magnitude | (B1) Permanence | (B2)Reversibility | (B3) Cumulative | Environmental Classification | Class Value | Probability |
|---|---|---|---|---|---|---|---|---|---|
| Daily Operations | Over-abstraction of the local aquifer, decrease in the local hydraulic head. | 2 | -2 | 2 | 2 | 2 | -24 | -3 | Probable |

**Desired Outcome:** To utilise the groundwater on a sustainable level.

**Actions**

**Prevention:**

- Spread the water abstraction points over a larger area to diffuse the impact.
- Monthly water level monitoring.
- Maintain safe abstraction rates prescribed by MAWF in the abstraction permit.

**Mitigation:**

- Reduce abstraction when the water levels nears 10 m below the average water level of each borehole.

**Responsible Body:**

- The proponent

**Data Sources and Monitoring:**

- Monthly water rest water level monitoring.
- Baseline values should be reviewed every 3 years based on all historic water level data.
- A summary report on all monitoring results must be prepared.

### 8.2 GROUNDWATER, SURFACE WATER AND SOIL CONTAMINATION

Leakages and spillages hazardous substances from earthmoving vehicles and accidental fuel, oil or hydraulic fluid spills during the construction phase. Increase of nutrient levels (from over application of fertilizers) in the soil that can leach to the groundwater. Pollution due to sewerage system overflow or leakage. Overuse / incorrect application of pesticides may also pose a risk. Leakage from sewerage systems.

**Table 8. Assessment – Groundwater, surface water and soil contamination**

| Project Activity / Resource | Nature (Status) | (A1) Importance | (A2) Magnitude | (B1) Permanence | (B2)Reversibility | (B3) Cumulative | Environmental Classification | Class Value | Probability |
|---|---|---|---|---|---|---|---|---|---|
| Construction | Hazardous material, spillages, hydrocarbon leakages from vehicles and machinery. | 2 | -2 | 2 | 2 | 1 | -20 | -3 | Improbable |
| Daily Operations | Hazardous material, spillages, hydrocarbon leakages from vehicles and machinery. Over application of fertilizer, pesticides, etc. Sewerage system malfunction. | 2 | -2 | 2 | 2 | 2 | -24 | -3 | Probable |

**Desired Outcome:** To prevent the contamination of groundwater, surface water and soil.

**Actions**

**Prevention:**

- Appoint reputable contractors.
- Vehicles may only be serviced on a suitable spill control structure.
- Regular inspections and maintenance of all vehicles to ensure no leaks are present.
- All hazardous chemicals should be stored in a sufficiently bunded area.
- Follow prescribed dosage of fertilizers and pesticides and to avoid over application.
- Maintain sewerage systems and conduct regular monitoring.
- All hazardous waste must be removed from the site and disposed of timeously at a recognised hazardous waste disposal facility, including any polluted soil or water.

**Mitigation:**

- All spills must be cleaned up immediately.
- Consult relevant Material Safety Data Sheet information and a suitably qualified specialist where needed.

**Responsible Body:**

- The proponent
- Contractors

**Data Sources and Monitoring:**

- Maintain Material Safety Data Sheets for hazardous chemicals.
- Soil should be sampled and analysed annually to ensure the correct amounts of fertilizer is applied and soil and groundwater quality is maintained.
- Groundwater should be sampled and analysed to test for nitrate concentrations from the fertilizer and for traces of chemicals used in pesticides and herbicides.
- Registers be kept by the farmers on the type, quantities and frequency of application of fertiliser, pesticides and any other chemicals utilised in crop production.
- A register of all incidents must be maintained on a daily basis. This should include measures taken to ensure that such incidents do not repeat themselves.
- All spills or leaks must be reported on and cleaned up immediately.

# 9 CONCLUSION

Groundwater on the farm is high yielding and can be used for irrigation. Based on current water level fluctuations in the area, as presented in Figure 10, a short term rest water level threshold of 10 m below the average water level of each borehole is set from where abstraction rates should be reduced. This threshold may require adjustment during drought periods as abstraction from neighbouring farms may also influence the regional water levels.

Careful cooperation between farms utilising water from the aquifer, on neighbouring farms and beyond is required to optimally utilize the groundwater resource without depleting it, as depletion will be detrimental to all. This should include self-monitoring and assessment of water levels in the area as data obtained from DWA indicates a lack of sufficient monitoring in the recent years. Proper monitoring data will provide the required information to make informed decisions and will assist to obtain increased abstraction volume permits when needed and if justified.

Groundwater vulnerability to contamination would be the highest around boreholes, around geological structures as well as where shallow groundwater is present. Contaminated surface runoff can create a pathway to the groundwater, putting the groundwater at risk. Potential sources of groundwater pollution include normal runoff from roofs, properties and surfaced areas, e.g. roads. These impacts are normally of a low magnitude and can be managed through proper housekeeping.

Based on current water level and abstraction volumes it seems as if higher abstraction volumes may be considered.

# 10 REFERENCES

AGROBEST,. (2015). Website: https://www.agrobest.com.au/news/How-Soil-pH-affects-availability-of-plant-nutrients-7.htm. Obtained on 18/09/2019.

Division of Agriculture and Natural Resources, University of California., (2019). Website: https://ucanr.edu/sites/Salinity/Salinity_Management/Effect_of_salinity_on_soil_properties/Effect_of_pH_sodicity_and_salinity_on_soil_fertility_/. Obtained on 21/11/2019.

IDB,. (2019). Index Database - Sensor: ASTER, Landsat 8. Website: https: //www.indexdatabase.de/db/s-single.php?id=9. Obtained on 25/06/2019.

Japan International Cooperation Agency,. (2002). The Study on the Groundwater Potential Evaluation and Management Plan in the Southeast Kalahari (Stampriet) Artesian Basin in the Republic of Namibia.

Kirchner, J., Tredoux, G., Wierenga, A., Christelis, G. & Wrabel, J. (2002) International Atomic Energy Agency (Raf 8/029) Sustainable Development of Groundwater Resources in the Africa Region – Technical Report: Namibia: Assessment of the Recharge to the Stampriet Artesian Basin to Formulate a Groundwater Management Plan for Sustainable Use of the Resource in the Southeast Kalahari in the Republic of Namibia. Geohydrology Division Department of Water Affairs.

NNDC Climate Data Online., (2019). Global Summary of the Day (GSOD). Website: https://www7.ncdc.noaa.gov/CDO/cdoselect.cmd?datasetabbv=GSOD&countryabbv=&georegionabbv=. Obtained on 19/11/2019.

Orange-Senqu Water Information System., (2018) Website: http://wis.orasecom.org/stas/. Obtained on 29/11/2019

Peck, H., (2009). The Preliminary Study of the Stampriet Transboundary Aquifer in the South East Kalahari/Karoo Basin. A thesis submitted in partial fulfilment of the requirements for the degree of Master of Science. Department of Earth Science Faculty of Natural Science University of the Western Cape, Cape Town

Peck, H., Sarma, D. & Xu, Y., (2009) The Preliminary Study Of The Auob Transboundary Aquifer In The South East Kalahari/Karoo Basin. UNESCO Chair Centre in Hydrogeology University of the Western Cape.

Soilquality.org.ua., (2019). Fact Sheet Total Organic Carbon. Website: http://www.soilquality.org.au/factsheets/organic-carbon. Obtained on 21/11/2019.

Te Chow, V., (1964). Handbook of Applied Hydrology. A Compendium of Water-resource Technology. University of Illinois. McGraw-Hill Book Company.

The Ministry of Agriculture Water and Forestry (MAWF)., (2019). Personal Communication.

# Appendix C: Proof of Public Consultation

## Notification Letter

TEL.: (+264-61) 257411 ♦ FAX.: (+264) 88626368
CELL.: (+264-81) 1220082
PO BOX 11073 ♦ WINDHOEK ♦ NAMIBIA
E-MAIL: gpt@thenamib.com

**To:** **Interested and Affected Parties** **03 September 2019**

**Re:** **Environmental Impact Scoping Assessment and Environmental Management Plan for Irrigation and Hospitality Activities on Farm Campbellsdrei, Hardap Region**

Dear Sir/Madam

Geo Pollution Technologies (Pty) Ltd was appointed by Mr. Alwyn van Straten to undertake an environmental assessment for existing and proposed irrigation activities and guest accommodation on farm Campbellsdrei, Hardap Region. The assessment will be conducted according to the Environmental Management Act of 2007 and its regulations as published in 2012.

**Project:** Environmental Scoping Assessment and Environmental Management Plan for Irrigation and Hospitality Activities on Farm Campbellsdrei, Hardap Region

**Proponent:** Mr. Alwyn van Straten

**Environmental Assessment Practitioner:** Geo Pollution Technologies (Pty) Ltd

Approximately 34.5 ha of land is irrigated by means of micro irrigation and centre pivot systems. Irrigated fields consist of newly established citrus orchards and lucerne fields. Irrigation is from six production boreholes fitted with solar pumps.

Existing buildings include the main residence and staff houses. Various old buildings are being repaired and will be converted into chalets. Future plans include a crop packaging store, lodge and guest facilities, an airstrip, a consumer fuel installation, and expansion of irrigation activities.

All Interested and Affected Parties (I&APs) are invited to register with the environmental consultant to receive further documentation and communication regarding the project. By registering, I&APs will be provided with an opportunity to provide input that will be considered in the drafting of the environmental assessment report and management plan.

Please register as an I&AP and provide comments by **04 October 2019**.

To register, please contact:

**Fax:** 088-62-6368

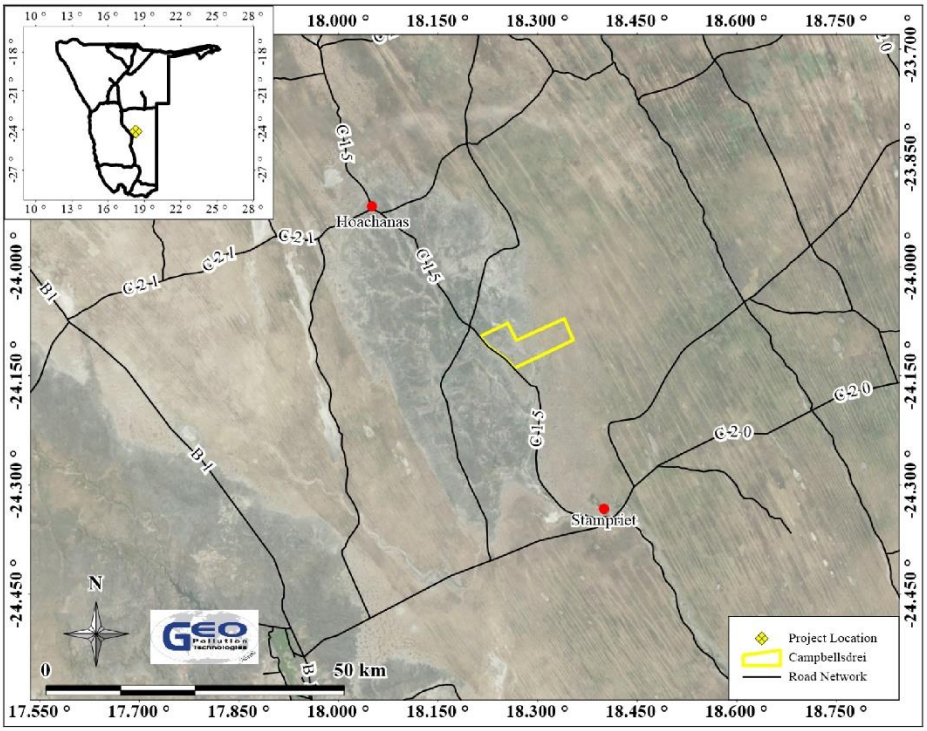
**E-Mail:** campbellsdrei@thenamib.com

Should you require any additional information please contact Geo Pollution Technologies at telephone 061-257411.

Thank you in advance.

Sincerely,
**Geo Pollution Technologies**

André Faul
Conservation Ecologist


Hoachanas
Stampriet
Project Location
Campbellsdrei
Road Network
N
0
50 km
18.000 °
18.150 °
18.300 °
18.450 °
18.600 °
18.750 °
17.550 °
17.700 °
17.850 °
-23.700 °
-23.850 °
-24.000 °
-24.150 °
-24.300 °
-24.450 °
B1
C14-5
C2-1
C2-0

## Advertisements 16 September 2019

2 NUUS Republikein Maandag 16 September 2019

KONTAKPERSONE

GENL. MURTALA MUHAMMEDRYLAAN. POSBUS 3436, WINDHOEK
TEL: 061 297 2000; FAKS: 061 223 721 ISSN 1560-9448

REDAKTEUR: Dani Booysen, 081 129 3781 / 061 297 2038, dani@republikein.com.na
NUUSREDAKTEUR: Ronelle Rademeyer, 081 127 8159 / 061 297 2114, ronelle@republikein.com.na
SPORTNUUS: Andrew Poolman, 081 247 2837 / 061 297 2011, andrew@republikein.com.na
BEMARKINGSKOÖRDINEERDER: Hennie Geldenhuys, 061 297 2201, hennie@nmh.com.na
SWAKOPMUND: Otis Finck 081 299 1211, otis@erongo.com.na, Faks: 064 403 451
OSHAKATI: Tel: 065 222 907, Faks: 065 222 898, oshakati@republikein.com.na
VERKOPE EN AFLEWERING: Ettienne Kotze 081 244 0928, ettienne@nmh.com.na, Tel: 061 297 2171
E-POS: REPUBLIKEIN@REPUBLIKEIN.COM.NA 'n Publikasie van NAMIBIA MEDIA HOLDINGS (Pty)Ltd, gedruk deur NEWSPRINT NAMIBIA (Pty)Ltd.

## WEER

**BINNELAND:** Sonnig en warm tot baie warm, maar bloedig warm in die Noorde.

**KUS:** Gedeeltelik bewolk en matig met mis-kolle.

**GETYE BY WALVISBAAI:** L 10:16 H 16:42 L 22:37

| | | |
|---|---|---|
| GOBABIS | 10° | 33° |
| KATIMA MULILO | 14° | 34° |
| KEETMANSHOOP | 15° | 30° |
| MARIENTAL | 17° | 33° |
| OPUWO | 14° | 35° |
| OSHAKATI | 17° | 35° |
| RUNDU | 16° | 36° |
| WALVISBAAI | 11° | 25° |
| WINDHOEK | 10° | 28° |
| LUANDA | 21° | 26° |
| JOHANNESBURG | 12° | 28° |
| KAAPSTAD | 14° | 22° |

## 'DONKER

op Okamatapati naby Okakarara se koorlede

### 'NAWEKE SKUIF ONS VEILIGHEID OPSY'

nente naamlik opvoeding, wetstoepassing, die toestand van die paaie,

Emgard (37), mnr. Siegfried Hausiku (ouderdom onbekend), die 13-jarige Kakuhire Katjeringo, me. Urioi Rukero (29), die sewejarige Mehepa Hepundjua Rukero en 'n ses maande ou babaseuntjie, Vizamuje Kavari.

Ndeitunga sê hy wil weet "hoe kon 'n redelike mens sitplekke gebruik is.

Ndeitunga sê dit is so dat die polisie en verkeerspolisie meer sigbaar op paaie moet wees, maar het bygevoeg "die publiek moet ook seker maak hul lewens word nie in gevaar gestel nie".

Mnr. Vetaruhe Kandorozu, streekraadslid 10 km buite Walvisbaai op die C14-pad omgeslaan het, word onder polisiebewaking in die staatshospitaal op die dorp behandel.

Dit volg nadat hy van strafbare manslag en dronkbestuur aangekla is.

Die 47-jarige mnr. Shikalepo Matheus Hamutenya, een van die twee passasiers in sy voertuig, is op die ongelukstoneel dood

wering 'n voertuig op 'n blinde hoogte verbygesteek toe hy van Tsumeb af in die rigting van Windhoek onderweg was.

Die 24-jarige bestuurder en drie van sy passasiers, 'n man, vrou en kleutermeisie, is op slag dood. Die ander drie insittendes is ernstig beseer.

Hulle is per ambulans na die Ongwediwa Medi Park

Hulle is as mee. Selma Kakolo Kahungu en Martha Aipanda uitgeken en die baba as Loide Latenda Fillipus.

Die 41-jarige bestuurder sal vandag in die landdroshof op Outapi op klagte van stafbare manslag en dronkbestuur verskyn.

- ronelle@republikein.com.na



## 'EK KIES OM DIE MOOI TE ONTHOU'

Ronelle Rademeyer

**"Ek kies om die mooi te onthou. Hy het sy foute gehad, maar hy was 'n goeie mens; hy was bemind."**

Só het me. Edith Ströh (49), suster van wyle mnr. Werner Beddies (47), hom gister beskryf.

Dit gons sedert sy dood in die sosiale media dat hy sy eie lewe geneem het deur Vrydag trompop naby Seeis in 'n Namlog-vragmotor vas te jaag.

Beddies, 'n bekende in die toerismebedryf en een van die vennote van Safari - An African Experience, word op die blad www.werner-beddies.com van bedrog beskuldig.

'n Eis om skadevergoeding van meer as N$500 000 is ook in die hoërhof in Windhoek teen hom hangend. Me. Yvonne Schadee, eienaar van die Vondelhof Guesthouse in Windhoek, eis vir pyn, lyding en vernedering nadat Beddies haar na bewering aangerand het.

Volgens die hofstukke het dit gebeur toe sy verlede jaar na sy onderneming in Sam Nujomaweg in Windhoek gegaan het om hom oor sy agterstallige skuld te konfronteer.

Ströh het gister aan *Republikein* gesê haar broer het hartprobleme gehad en het die afgelope week van pyn in die bors gekla. Daarbenewens het hy ook medikasie gebruik om te voorkom dat hy aan die slaap raak.

"My broers (Jürgen, 51, en Peter Beddies, 54) was vanoggend (Sondag) by die ongelukstoneel en hulle sê daar is remmerke op die pad. Hulle vermoed nie selfmoord nie."

Volgens haar sou hy dit nooit aan sy seun, Philipp (18), gedoen het nie. Hy is in Duitsland op skool en het gisteroggend in Namibië aangekom.

"Ja, dit is so dat hy finansiële probleme gehad het, maar hy was 'n goeie, liefdevolle en hardwerkende mens," het Ströh gesê.

Beddies laat benewens Ströh sy twee broers en sy seun, ook 'n jonger suster, me. Oetie Louw (38), en sy vrou, me. Jutta Beddies-Kulish, agter. Die begrafnisreëlings is nog nie bekend nie.

- ronelle@republikein.com.na



2 sun NEWS MONDAY SEPTEMBER 16 2019



## Editor's corner

## Death on wheels

## Deadly

CONTINUED FROM PAGE 1

The police confirmed that 42 people were in the 16-seater

"That was the reason. And four people died on the spot. I have no words; this is really sad. It's attitude in most cases, causing these accidents. It was a really sad weekend."

incidents, and everyone responds. But there are accidents each weekend, where one or two persons die on our roads. Unfortunately everyone is quiet then. It's an os-

six-month-old baby boy and a seven-year-old girl died in the Kalkfeld accident on Friday afternoon.

Also on Friday afternoon, well-known tourism person-

Contact details

Tel (061) 383 400 - Fax 306 853
P.O. Box 86829, Eros II
General Murtala Mohammed Road, Eros, Windhoek

Website: www.namibiansun.com
Email: sun@namibiansun.com

**Editor:** Festus Nakatana, festus@namibiansun.com
**News Editor:** Yanna Smith, yanna@namibiansun.com
**Sub-Editors:** Herma Prinsloo, Ashley Smith
**Reporters:** Ellanie Smit, Jemima Beukes, Jana-Mari Smith, Ogone Tlhage
**Sport Reporters:** Jesse Jackson Kauraisa, Limba Mupetami
**Entertainment Reporter:** Michael Kayunde
**Designers:** Aina Mushelenga, Theonistha Kohlman
**Oshakati** Ileni Nandjato 081 2021 667
**Rundu:** Kenya Kambowe 081 7241 044
**Erongo:** Otis Finck, otis@erongo.com.na, Tel (064) 403 443
**NMH Group Marketing Manager:** Hennie Geldenhuys, Tel (061) 297 2201, hennie@nmh.com.na
**Subscriptions:** Ettienne Kotze, Tel (061) 297 2076, ettienne@nmh.com.na

Namibian Sun is a publication of Namibia Media Holdings Pty (Ltd) and is printed by Newsprint Namibia ISSN 1997-4876



DIVUNDU VILLAGE COUNCIL

Tel.: + 0264 66 259414
Fax: +0264 66 258 367
Email address: info@divunduvc.com.na

P.O. BOX 5266
DIVUNDU
NAMIBIA

**PROCUREMENT MANAGEMENT UNIT**

**BID INVITATION**
**(REQUEST FOR SEALED QUOTATION BIDS)**

| | |
|---|---|
| Procurement Bid Reference number | W/RFQ/DVC -01/2019/20 |
| Description | Bid invitation for **Maintenance of gravel roads in Divundu Village** |
| Bid documents | Bid documents are available at Divundu village Council office at no cost, Erf no. 379, Trans Zambezi Highway Divundu – Kavango east, Tel; 066 -259414, at personnel office |
| Enquiries | Mr. Dinyando Adam or Ndara Moses Tel Number: 066 – 259414 Email address: info@divunduvc.com.na |
| Delivery address for admission of Bid | Quotations should be deposited in the Quotation/Bid Box located at Divundu Village Council reception not later than **27 September 2019 at 11h00**. Quotations by post or hand delivered should reach Divundu Village council by the same date and time. Late quotations will be rejected. Quotations received by e-mail will not be considered. |

Mr. A.K Dinyando
**Head of Procurement Management Unit**

12 September 2019

**Advertisements 23 September 2019**

2 NUUS Republikein Maandag 23 September 2019

KONTAKPERSONE

GENL. MURTALA MUHAMMEDRYLAAN. POSBUS 3436, WINDHOEK
TEL: 061 297 2000; FAKS: 061 223 721 ISSN 1560-9448

REDAKTEUR
Dani Booysen
081 129 3781 / 061 297 2038
dani@republikein.com.na

NUUSREDAKTEUR
Ronelle Rademeyer
081 127 8159 / 061 297 2114
ronelle@republikein.com.na

SPORTNUUS
Andrew Poolman
081 247 2837 / 061 297 2011
andrew@republikein.com.na

BEMARKINGSKOÖRDINEERDER
Hennie Geldenhuys
061 297 2201
hennie@nmh.com.na

SWAKOPMUND
Otis Finck 081 299 1211
otis@erongo.com.na
Faks: 064 403 451

OSHAKATI
Tel: 065 222 907
Faks: 065 222 898
oshakati@republikein.com.na

VERKOPE EN AFLEWERING
Ettienne Kotze 081 244 0928
ettienne@nmh.com.na
Tel: 061 297 2171

E-POS: REPUBLIKEIN@REPUBLIKEIN.COM.NA 'n Publikasie van NAMIBIA MEDIA HOLDINGS (Pty) Ltd, gedruk deur NEWSPRINT NAMIBIA (Pty) Ltd.

## WEER

**BINNELAND:** Gedeeltelik bewolk en warm in die Suide. Elders sal dit warm tot bloedig warm in die Noorde en Weste wees. Winderige toestande sal voortduur.

**KUS:** Mooiweer en warm tot baie warm met sandstorms in die Suide.

**GETYE BY WALVISBAAI: H** 10:31 **L** 16:46 **H** 23:10

**VOORUITSIGTE**

| | | |
|---|---|---|
| WINDHOEK | 17° | 30° |
| GOBABIS | 9° | 28° |
| KATIMA MULILO | 14° | 34° |
| KEETMANSHOOP | 10° | 26° |
| MARIENTAL | 14° | 27° |
| OPUWO | 14° | 36° |
| OSHAKATI | 17° | 38° |
| REHOBOTH | 16° | 30° |
| RUNDU | 17° | 34° |
| WALVISBAAI | 17° | 30° |
| JOHANNESBURG | 11° | 28° |
| KAAPSTAD | 14° | 20° |



DM020190034519 9

**PUBLIC PARTICIPATION NOTICE**
ENVIRONMENTAL ASSESSMENT: IRRIGATION / HOSPITALITY ACTIVITIES, CAMPBELLSDREI

Geo Pollution Technologies (Pty) Ltd was appointed by **Mr. Alwyn van Straten** to undertake an environmental assessment existing and proposed irrigation activities and guest accommodation on farm Campbellsdrei, Hardap Region. The detailed project location may be viewed at:

**http://www.thenamib.com/projects/projects.html.**

The environmental assessment will be conducted according to the Environmental Management Act of 2007 and its regulations as published in 2012.

Micro irrigation and centre pivot systems are used to irrigate approximately 34.5 ha. Irrigated fields consist of newly established citrus orchards and lucerne fields. Irrigation is from six production boreholes fitted with solar pumps. Buildings include the main residence, staff houses and buildings being converted into chalets. Future plans include a crop packaging store, lodge and guest facilities, an airstrip, a consumer fuel installation, and expansion of irrigation activities.

All Interested and Affected Parties are invited to register with the environmental consultant. By registering you are provided with the opportunity to share any comments, issues or concerns related to the project, for consideration in the environmental assessment. Additional information can be requested from Geo Pollution Technologies.

All comments and concerns should be submitted to Geo Pollution Technologies by **04 October 2019**.

**André Faul**
Geo Pollution Technologies
**Telephone:** +264-61-257411
**Fax:** +264-88626368
**E-Mail:** campbellsdrei@thenamib.com

"Die tande het in 'n stadium 'n permit gehad, maar dit het verval ná die oorspronklike eienaar se afsterwe. Hy het die tande 20 jaar gelede as 'n trofee in Botswana bekom," het Frans getuig.

"Die oorspronklike eienaar het by dieselfde visfabriek as Edwards gewerk. Die eienaar het Kaapstad toe getrek en Edwards versoek om die tande na een van die visfabriek se bote te bring. Die tande is op die boot gelaai en toe dit by Lüderitz vasmeer, het die polisie die boot se kaptein en bemanning in hegtenis geneem ná hulle die tande gevind het," het Frans gesê.

"Toe het die tande steeds 'n geldige permit gehad, die verdagtes was 'n ruk in die polisieselle op Lüderitz en die saak is later teruggetrek. Die tande is na 'n prokureur wat die bemanning verteenwoordig het, oorgeteken. Die prokureur het die tande aan Edwards oorhandig, wat dit op Walvisbaai des toegestaan.

Al drie beskuldigdes moet hul paspoorte aan die ondersoekbeampte oorhandig en mag nie om nuwe reisdokumente aansoek doen nie. Hulle moet ook drie keer 'n week by die Walvisbaaise polisiekantoor aanmeld.

Die saak is tot 28 November uitgestel.

Die staatsaanklaer Tuihaleni Hilikuete verskyn vir die staat, en die beskuldigdes word deur mnr. Jan Wessels verteenwoordig.

leandrea@republikein.com.na

Mnr. Michael Lusse
FOTO FACEBOOK

4 sun NEWS MONDAY SEPTEMBER 23 2019

FRANK TALK | ELECTIONS 2019

## What govt gives it first takes awayworth

# On their knees

**PUBLIC PARTICIPATION NOTICE**
ENVIRONMENTAL ASSESSMENT: IRRIGATION / HOSPITALITY ACTIVITIES, CAMPBELLSDREI

Geo Pollution Technologies (Pty) Ltd was appointed by **Mr. Alwyn van Straten** to undertake an environmental assessment existing and proposed irrigation activities and guest accommodation on farm Campbellsdrei, Hardap Region. The detailed project location may be viewed at:

**http://www.thenamib.com/projects/projects.html.**

The environmental assessment will be conducted according to the Environmental Management Act of 2007 and its regulations as published in 2012.

Micro irrigation and centre pivot systems are used to irrigate approximately 34.5 ha. Irrigated fields consist of newly established citrus orchards and lucerne fields. Irrigation is from six production boreholes fitted with solar pumps. Buildings include the main residence, staff houses and buildings being converted into chalets. Future plans include a crop packaging store, lodge and guest facilities, an airstrip, a consumer fuel installation, and expansion of irrigation activities.

All Interested and Affected Parties are invited to register with the environmental consultant. By registering you are provided with the opportunity to share any comments, issues or concerns related to the project, for consideration in the environmental assessment. Additional information can be requested from Geo Pollution Technologies.

All comments and concerns should be submitted to Geo Pollution Technologies by **04 October 2019**.

**André Faul**
Geo Pollution Technologies
**Telephone:** +264-61-257411
**Fax:** +264-88626368
**E-Mail:** campbellsdrei@thenamib.com

Johanna Ndumba (79), who lives with her grandchildren and great-grandchildren at Ngaramateya village in the Rundu Urban constituency is pleading for support, as they have no source of income.

The ongoing drought has brought the family of eight to their knees and they are finding it hard to survive.

They sleep on the bare floor and no mahangu was harvested this season, due to the poor rainfall.

Due to a lack basic necessities, the younger members of the family are not attending school and have no school uniforms.

Ndumba, who is visually-impaired, relies on the assistance of her grandchildren when she has to move around.

Her granddaughter Sarafina Mukuve (19), who dropped out of school after she fell pregnant, is now the proud mother of a two-year-old boy.

Mukuve said their worst challenge is a lack of food, as their mahangu reserves have been depleted.

With no one employed in the household, the family relies on the income they make from selling Mauni, known as monkey oranges.

They sell along the Rundu-Divundu main road and the meagre earnings are used to buy maize meal

**HOME: The family's homestead.**
PHOTOS: KENYA KAMBOWE

**Site Notice**


PUBLIC NOTICE:
ENVIRONMENTAL ASSESSMENT FOR IRRIGATION AND HOSPITALITY ACTIVITIES ON FARM CAMPBELLSDREI, HARDAP REGION

# Appendix D: Comments and Responses Table

## Comments and Responses Received During Assessment Phase

**Dr. Y. Hemberger: E-mail 18 September 2019**

**Comment:**

Our concerns include the following:

- Soil and groundwater pollution - tourist business and fuel station
- Groundwater over-abstraction - Kalahari water basin has limited resources
- Fire risks - tourist business
- Waste and effluent generation and disposal- tourist business
- Ecosystem and biodiversity impacts - citrus mono culture and tourist business

More explanation on the points above will follow before the 4/10/2019.

**Response:**

These concerns were addressed in the report under various headings. Preventative and mitigation measures provided under sections 10.1.11, 10.1.12, 10.1.14, 10.1.15 and 10.1.16 and Appendix B.

**Mr. F. Oosthuizen: E-mail 19 September 2019**

**Comment:**

I, Fredrick J Oosthuizen, Owner of Farm Oliva 122 Stampriet, has no objections regarding matters mentioned for environmental impact assessment in favor of Farm Cambellsdrei.

**Response:**

Noted

**Dr. Y. Hemberger & Family Vrey: E-mail 18 September 2019**

Comments for the BID Campbellsdrei sent by Farm Lidfontein No 136 Family Vrey and Dr. MY Hemberger, Dated 27/09/2019

Find below the explanations and risks for the STAS system if the development will take place as stipulated in the BID, especially the pollution, ecosystem and biodiversity impacts.

1. **Ecosystem and Biodiversity impacts due to citrus mono culture and tourist business**

2. **The Stampriet Transboundary Aquifer System (STAS) protection has to be considered before establishment of the Campbellsdrei development may take place.**

Groundwater is public property, with control vested in the State. The Water Resources Management Act (Act no. 11 of 2013) makes provision for control and protection of water resources from over abstraction and pollution through a licensing system. The Act has a detailed chapter on control and protection of groundwater. The existing regulatory framework for groundwater abstraction and use is reasonably adequate.

Similar to water abstraction, discharging of wastewater is controlled through a permit system. Permit holders are responsible for reporting to the MAWF - Department of Water Affairs on adherence to conditions. The Department of Water Affairs also does periodic inspections of wastewater quality that is discharged by permit holders.

Management of the STAS is especially provided for, as the aquifer is declared as a "water protection area" under the Water Resources Management Act 2013. An area is declared a water protection area in order to protect and enhance the water resources or its habitat against risks of significant changes to resource quality, depletion, contamination, extinction or disturbance from any source. Regulatory enforcement within water protection areas is expected to receive due attention.

Other than the Water Resources Management Act 2013 that is focused on freshwater, Namibia also has an Environmental Management Act (EMA), which aims at promoting sustainable management of the environment and use of natural resources. The Environmental Management Act is broad; it regulates land use development through environmental clearance certification and/or Environmental Impact Assessments. The Act provides for clearance certification for surface or groundwater abstractions for industrial or commercial purposes in order to protect water resources.

## Groundwater pollution: sources, vulnerability and pollution risk

Currently there is generally very low pollution risk for the STAS area as a whole, but selected locations (settlements) and zones (in particular: irrigated lands) form exceptions. Groundwater pollution risk in the STAS area can arise from localized pollution sources, in combination with the aquifer's vulnerability to pollution.

In settlements, this risk is associated with the following sources of pollution:
- Pit latrines,
- Septic tanks and effluent soakways,
- Sewage works & oxidation ponds,
- Burial sites,
- Oil/fuel storage and disposal.

In rural areas, pollution risk is mainly associated with:
- Irrigation (in combination with the use of fertilizers and pesticides)
- Livestock excreta

In Namibia the main potential pollution sources are oxidation ponds, septic tanks and landfills close to settlements, and irrigation fields. There are some localized threats of pollution to the Kalahari aquifers from polluting sites around settlements, but current information indicates that this pollution does not penetrate to the Auob and Nossob aquifers. Besides these pollution sources, groundwater pollution can occur as a result of the use of fertilizers and pesticides in the irrigated lands and by cattle urine and dung at watering points near wells and boreholes. The shallower Kalahari aquifers are prone to pollution risk related to irrigation in the Stampriet area (where 80% of the total irrigation of the STAS is concentrated) and along the Nossob River between Leonardville and Aranos.

## Groundwater pollution sources and their aggregated intensity in the STAS
(Source: Muroua, 2015; Mosetlhi, 2015 and CGS, 2015)

**Pollution Source:**

1. **Irrigation (incl. use of fertilisers & pesticides)**
   **Risk Medium-High:**
   Irrigation poses the most significant pollution threat to groundwater. However the intensity of this source is reduced by the fact that the irrigation farms area scattered not continuous, and the total area under irrigation is around 620ha.
2. **Septic Tanks & Effluent Soakaways**
   **Risk Medium:** As there is high use of septic tanks in centres like Aranos, Aminuis, Kries, Stampriet, Hoachanas and Leonardville.
3. **Sewage Works & Oxidation Ponds**
   **Risk Medium-High:** Because there is use of oxidation ponds to manage effluent in all the urban centres. Also, most of the oxidation ponds were constructed before the new ponds standards were adopted hence they are not sealed with the necessary impermeable structures to avoid seepage effluent in to groundwater.
4. **Oil/Fuel Storage & Disposal**
   **Risk Medium:** This relates to storage & disposal of oils or fuels used in service stations, and irrigation & borehole related machinery.
5. **Tourists and livestock holdings**
   **Risk Medium:** Some of the risks are listed above (see points 2/3/4) additional risks especially for the surrounding farms: fire and noise, as well as environmental pollution due to excessive waste. Usually you will find small dumping sites on farms for burning the waste material, including hazardous waste (as oily material and plastics). In case of tourism excessive waste material are cumulated and it possess a risk for the surrounding farms and the environment as such.

The confined transboundary aquifers have very low vulnerability to pollution, due to the series of poorly permeable layers that separate them from the pollution sources at the land surface. Nevertheless, they will experience higher withdrawal pressures if overlying Kalahari aquifers become polluted. The shallower and usually phreatic Kalahari aquifers have much less natural protection and are therefore vulnerable to pollution; **in particular in the Namibian sector the pollution risk is often medium to high due to irrigated agriculture (using fertilizers and pesticides, and applying water which acts as an agent of transport) and due to environmentally unfriendly sanitation and waste disposal practices.**

## Groundwater resources degradation by depletion

Although the available information on groundwater replenishment is very limited, it may be concluded that the Kalahari aquifers are only weakly recharged, while the Auob and Nossob aquifers receive so little recharge that they preliminary can be ranked in the category of aquifers with non-renewable groundwater resources. This means that progressive ground water depletion (accompanied by steadily declining groundwater levels) is a realistic threat to the STAS area. Infrequent wet years may produce some recovery of the water levels –as observed several times in the area during the last decades–, but on the longer term this might not be sufficient to prevent long-term depletion, in particular when groundwater abstraction intensities in the area increase.
The hydrodynamic regime of the STAS thus is very fragile, which requires special attention to be paid to: controlling groundwater abstractions in order to keep medium- to long-term depletion within acceptable limits; curbing current waste of water and avoiding it to occur in the future.
New malfunctioning wells appear because of the lacking control of drilling activities. As a result, the aquifer system is often damaged by permanently wasting water when boreholes penetrating the Auob and Nossob confined aquifers are not properly sealed. The reasons of the latter might be illegal drilling activities, cost-saving, minimal supervision when casing and seals were placed.

**Response:**

Concerns and information provided are noted. Concerns were addressed throughout the report and specifically in sections 10.1.11, 10.1.12, 10.1.14, 10.1.15 and 10.1.16 and Appendix B.

**Jaco Kotze, Stampriet Farmers Association: E-mail 06 October 2019**

# Mariental Streekslandbou-Unie

*P O Box 168*

*Mariental*

*antoiburger@gmail.com*

Stampriet 4 October 2019

**MEMORANDUM of the MSLU regarding sustainable use of underground water resources in the Stampriet aquifer**

The meeting on the 20th September 2019 in Mariental necessitates the Mariental Regional Farmers Union (MSLU) to convey the following official note to the project committee as well as to the relevant Namibian authorities and Ministries:
The MSLU is the regional representative body of 11 commercial farmers unions within the Hardap region and represents 457 members. MSLU is a regional sub institution of the mother body, the Namibian Agricultural Union (NAU).

History:
The population and development within the greater Kalahari basin have always been under the restriction of sufficient water supply as no perennial rivers flow through this semi desert environment. The scarce water resources therefore were regarded to primarily support the inhabitants, wildlife and the domestic stock. Modern technology enables mankind to reach very deep into ground water resources and advanced irrigation technology has opened a series of new possibilities. Water now and even more so in the future is possibly the most precious resource on our planet and the predictions and indications project that even wars will be waged to secure access to fresh water for human consumption. Uncontrolled large-scale water abstraction for irrigational or mining purposes puts a large number of extensive livestock and game farms with the associated work opportunities and livelihoods at a severe risk.

Namibian Constitution:
The Namibian Constitution grants the right to its citizens to utilize the natural resources however with one cardinal precondition: This utilization must at all times fulfill the test of sustainability- ***SUSTAINABLE UTILISATION*** will be the yard stick with which the ever-increasing world population will determine their own future and destiny. The Namibian citizens are by no means excluded from this test of sustainable utilization at all, as indicated by our constitution.

1

Development:

Socio- economic development and the creation of infrastructure is often regarded as progress per se – however it has to pass the test of sustainability – many developments have been initiated for own short-term financial gains under the smoke screen of the motto "what pays stays" and are herewith reduced to solely economic formulas.

Stampriet Aquifer

Several international scientific studies have been made over time regarding the size and the renewability of the Kalahari artesian water system(s). It seems that the volume of this underground aquifer has been quantified scientifically. However, regarding one of the principal questions from which geographical area(s) this aquifer is recharged and at what volumes, no definite scientific answers are available. Records of our annual precipitation are 100 years and older and they give us a good indication of the amount of water that we can expect. Science however tells us that only between 0,4% and 3 % of the water eventually lands in the underground water reserve, approximately 84 % evaporate -13 % are transpired by plant life. Thus, an interesting formula of the actual annual recharge by rainfall directly over or on the Stampriet area is thus far the ***only measured definite recharge*** that we can bargain on without risking the long-term sustainability of this precious resource

1 mm rainfall = 1 l/sq m
10 mm rainfall = 10 l/sqm
100 mm rainfall = 100 l/sqm
200 mm rainfall = 200 l/sqm
X 10 000 = 2 000 000 l / ha = 2mil l /ha
A meager 3% of the annual precipitation eventually reaches the underground water resource.
Thus, 2mil l/ha x3% = 60 000l/ha reaches the aquifer
This is the equivalent of 60 cub/ m /ha /annum
As long as no reliable water abstraction as well as regular measurements of the depth of the water table data are recorded and channeled and registered by NAMWATER, or any other controlling institution, this simple formula is the only guarantee that we will exploit said reserve on a sustainable basis, e.g. on 5000 ha the water abstraction quota should not exceed 300 000 cub/m as delivered from all boreholes used for irrigation on that surface of 5000ha
Is the size of the project 1000 ha, only 60 cub/m x 1000 ha = 60 000 cub /m may be used per year.

The study of the GTZ and a Japanese survey informed the farming community some 15 years ago already that with recorded and reported water abstraction to Namwater – the Auob aquifer would be depleted in 2038! We all know that the illegal, unauthorized sinking of boreholes and the unreported abstraction of water for irrigation purposes is a huge problem as control seems to be lacking completely. ***"To measure is to know"*** therefore statistics of the annual water consumption as well as continuous measuring of water table levels are of utmost importance, a prerequisite for ***SUSTAINABLE WATER MANAGEMENT.***

2

Lessons in other parts of the world:
Examples from Texas and California in the USA and vegetable producing areas in Spain have clearly proven that the water table has sunk tremendously due to unsustainable usage - in some areas the level has sunk from 100 m to more than 300 m. This alarming development has also adverse influences on the natural botanical composition as well as on the weather patterns in the mentioned areas. ***The philosophical question should therefore be asked whether ground water resources should be used for irrigational purposes at all.***

The GGRETA Project: Stampriet case study:
Context, methodology and progress
Andrew Ross
Senior groundwater governance specialist UNESCO-IHP
• GGRETA project on transboundary groundwater
governance - design, methodology
Risks and challenges • The biggest potential risk to the STAS comes from possible largescale irrigation or mining development. Current management challenges include: • Data deficits especially time series data – Where data exists it is incomplete, poorly organized, difficult to retrieve
• Risk of local pollution around settlements – Pit latrines, oxidation ponds, waste dumps, poorly maintained bores
• Implementation of law and policy – Gaps in regulations, limited inspection and controls

**The recommendations of the MSLU:**

No further permits to sink new boreholes and no new water quotas should be issued for any extension of irrigation projects in the Stampriet basin unless the following preconditions have been met:

1.) Only when the total farming community in the Hardap region and in the bigger Stampriet artesian and sub-artesian basin, that also reaches into at least two more regions, namely Khomas and Omaheke, are informed and are satisfied that a scientific study and monitoring system, that defines the annual recharge volume and the origin thereof of the Stampriet Aquifer as well as sustainable water abstraction data and water level measurements, have been tabled and condoned by the mentioned communities in the spirit of public-private partnership.

2.) The current Namibian water act is explicit regarding Aquifer management - however if the government does not have the financial means to gather absolute reliable abstraction data and to enforce the law – this may under no circumstances be exploited and lead to misuse of this precious resource. The irrigation farmers in their own interest should therefore establish, equip and maintain these basin management committees in order to accountably, transparently and scientifically prove to the government of the day and the general public that this precious resource is utilized according to sustainable

3

standards at all times. The MSLU is in the process, in collaboration with its members, in establishing such a monitoring system.

3.) Permanent and continuous measurements as well as statistics regarding water abstraction as well as continuous graphs of the ground water table must be kept to be able to control and to ***warrant a sustainable utilization of this precious resource*** over time. The mentioned communities must agree that the necessary checks and balances are in place and the communities must be integrated into any future monitoring system. (= basin management committees)

4.) Every borehole that is used for irrigation must have a water meter installed; the abstraction volumes must be recorded and sent to the controlling institution.

The MSLU wants to state categorically that any above-mentioned control mechanisms should not be interpreted as an effort to jeopardize progress and development but as a sincere effort to promote SUSTAINABLE UTILISATION of our precious natural resources.

President Dr Hage Geingob contributed to the 73rd session of the United Nations General Assembly and I quote a sentence at the very end of his speech: <It is time to lead in the spirit of peace, in the spirit of equality and in the spirit of ***sustainability***.>

In the light of the world's climate change we can allow nobody to take any shortcuts, only responsible water abstraction backed by adequate scientific data will guarantee SUSTAINABLE UTILISATION.

pp .....
C.D.Smith

Chairman Mariental Regional Farmers Union

**Response:**

Memorandum noted and communicated to the proponent.

# Appendix E: Comments Received during Public Review of the EIA / EMP

## E-mail: Dr. Y. Hemberger & Mr. D. Very, 01 March 2020

(Comments are presented as received and only minor formatting changes were applied)

| Comments | Responses |
|---|---|
| 1. See in No. 11 of 2013: Water Resources Management Act, 2013. And add 9.5 Impact on surface water runoff from dam renovation/increase of height of dam wall. This must be addressed as an identified impact on surface water runoff than continue with Fire under 9.6 | 1. Surface water containment was addressed in Section 9.3. Note that the Water Resources Management Act of 2013 is not in force yet and, to date, no regulations have been set forth. |
| 2. EIA/EMP does not provide sufficient information, it is more or less a listing of farming business possibilities. This might be enough for an EIA, but definite not for an EMP. An EMP requires detailed data about the project that the risks can be discusses and mitigated. | 2. The listed activities of the Environmental Management Act that are triggered, and thus need assessment, are forest activities (mainly debushing), pest control (if any) abstraction of groundwater for irrigation, fuel storage, a runway (airfield) and construction of the lodge and campsites. These have been discussed in various sections of the report to such a degree that we are comfortable with identifying and addressing the impacts. It is also in line with previous EIAs of similar nature that was submitted to, and approved by, the Ministry of Environment and Tourism. |
| **General information and structure for section 10 .**<br><br>**General Project and Site Information**<br><br>1. Should include a descriptive part that characterizes the project, specifies institutional and regulatory aspects, describes technical project content, outlines any potential need for capacity building and briefly characterizes the public consultation process. This section should indicatively be up to two pages long. Attachments for additional information may be supplemented as needed.<br><br>2. Safeguards Information includes a screening checklist of potential environmental and social impacts, where activities and potential environmental issues can be checked<br><br>3. Mitigation Measures represents the environmental mitigation plan to follow up proper implementation of the measures triggered under Part 2.<br><br>4. Monitoring Plan contains a simple monitoring plan to enable both the Contractor as well as authorities to monitoring due implementation of environmental management and protection measures and detect deviations and shortcomings in a timely manner.<br><br>5. Part 2 and 3 should be structured in a way to provide concrete and enforceable environmental and social measures, which are understandable to non-specialists (such as Contractor's site managers) and are easy to check and enforce. The EMP should be included in the BoQ (bill of quantities) and the implementation priced by the bidders. Part 4 should also been designed intentionally simple to enable monitoring of key parameters with simple means and nonspecialist staff. | 1. All these aspects have been discussed in the EIA section of the report. To repeat it in the EMP section, of the same document, will unnecessarily lengthen and complicate the document, as well as increase the number of pages that needs printing for submission (environmental impact). Furthermore the EIA and EMP accompanies each other and should be easily followed by the Proponent for implementation.<br><br>2. The screening process for impacts was completed internally and the results included in the EIA / EMP.<br><br>3. These are included in Section 10 under each impact.<br><br>4. These are included in Section 10 under each impact.<br><br>5. It is the proponent's responsibility to include the EMP as part of the contracts with contractors and employees (see section 10.1.1). It is also his responsibility to appoint a health, safety and environmental (HSE) officer (if not himself), who must see to the refining and implementation of the EMP and all its mitigation and monitoring aspects. Importantly, distinction should be made in the scale of this project compared to the scale of mega-projects, like mining, and the level of requirements that are attached to each respective project. |
| **Increased Crop Yield** | |

| Comments | Responses |
|---|---|
| 1. This section does not explain which activity will be carried out in your project!<br><br>2. You write about the advantages of irrigation, but you need to remember that you have a permit for 50 000 cubic irrigation water only, this will be sufficient for approximately 5000 h of crops/trees.<br><br>3. It is not clear which type of farming will be carried out: you mention fertilizers first, than you write about organic farming?<br><br>4. Mono cultures and mechanization for increased production, therefore, may not always be a desirable or appropriate policy target. In many developing countries, a lack of on-farm facilities for post-harvesting and handling of crops, coupled with limited economic channels of crop disposal, may form a critical bottleneck that has the effect of neutralizing all benefits due from mechanized tillage and/or crop protection investments.<br><br>5. "…flow of revenue"..: Although jobs are created, most are relatively low-level. These low-wage, low-skill workers have little prospect for advancement or promotion. "…have a positive impact on the economic sphere of the environment…." Here the word environment is not correct, as only the proponent will benefit! | 1. The project description in section 4 states that citrus and lucerne are currently the crops planted. However, within the agricultural industry, the farmer may plant other crops or introduce other farming elements as he/she sees fit for the farms potential. The EIA does not restrict the proponent to only the crops mentioned in the report. Therefore the general statements in section 10.1.2.<br><br>2. By planting citrus for a niche market, the monetary return on each $m^3$ of water invested, is much higher than for example planting low income crops. Furthermore, if the statement is understood correctly, it is implied that there is no advantage in planting crops if you can only plant small areas. This would disqualify a very large portion of Namibia's agronomic producers from carrying on with irrigated cropping.<br><br>3. The proponent intends to practice organic farming, but this does not exclude the possibility of farming using fertilizers and pesticides in other areas, or switching from organic to "non-organic" if he so chooses. Thus, pesticides and fertilizers are also included to cover such potential events.<br><br>4. It is not for the environmental consultant to decide that the Proponent, or any other farmer, does not have the capability to harvest, package and deliver his/her crops to markets. Furthermore, during this assessment it was clear that the proponent has done significant research as to the feasibility of this project. It would not make business sense for him not to make sure of possible markets before investing in the project.<br><br>5. While it is true that the Proponent will benefit, that is the ultimate goal of investment in business opportunities after all, employees will also benefit. In all instances where, within the requirements of the Labour Act and any other legislation pertaining to employment in Namibia, employment is offered to local Namibian citizens, it can only be regarded as a positive. If not, the unemployment rate in Namibia would be much higher than it already is. The Proponent did indicate that most of his workers are skilled in at least one vocational skill (e.g. welding, building, etc.). Without a doubt, employees will also learn from each other and thus increase their skills and knowledge. He also indicated that they are remunerated in accordance with their respective skills and at rates significantly higher than minimum wage. In future, no one prohibits any of the employees to, if not satisfied with the status quo, look for better prospects elsewhere. |

| Comments | Responses |
|---|---|
| | Furthermore, the definition of environment as indicated on page 1 includes the social and economic spheres:<br><br>"As defined in the Environmental Assessment Policy and Environmental Management Act - "land, water and air; all organic and inorganic matter and living organisms as well as biological diversity; the interacting natural systems that include components referred to in sub-paragraphs, the human environment insofar as it represents archaeological, aesthetic, cultural, historic, economic, palaeontological or social values" |
| **Skills and Development**<br><br>1. "…flow of revenue"..: Although jobs are created, most are relatively low-level. These low-wage, low-skill workers have little prospect for advancement or promotion.<br><br>"…have a positive impact on the economic sphere of the environment…." Here the word environment is not correct, as only the proponent will benefit! | See previous responses for "Increased Crop Yield" |
| **Tourists and lodge**<br><br>1. Tourism can often cause environmental damage with risks like erosion, pollution, the loss of natural habitats, and forest fires. Even if tourists behave responsibly, the sheer number of them can cause damage. Ancient buildings, monuments, and temples often struggle to cope with increased traffic and suffer inevitable wear-and tear. Reefs and other natural tourist attractions can suffer permanent damage.<br><br>2. Cultural. The commercialization of culture can undermine the soul of a tourist destination. Local traditions that have a rich cultural heritage are reduced to wearing costumes and putting on acts for the tourists in return for money.<br><br>3. Culture Clashes. Tourists often lack respect for local traditions and culture, refuse to follow local dress standards, get drunk in public, or behave rudely or inappropriately towards locals.<br><br>4. Seasonal Fluctuations. Tourism jobs are quite commonly seasonal and insecure, with no extra benefits such as pensions, sick pay, or healthcare. Some areas can be inundated with visitors during busy times, and then virtually deserted for many months.<br><br>5. Imbalanced Funding. Money can end up being directed to tourist areas when it could be used more effectively elsewhere in a country. The locals who don't live in specific tourist areas miss out and suffer relative decline. | 1. All old structures were in a state of disrepair and left derelict by the previous owner and community. Tourism will advance the proponent's current initiatives to preserve the heritage and promote environmental awareness and conservation through eco-tourism. See photos below of the derelict state of the farm when acquired. Since then all waste has been collected and discarded and restoration of buildings commenced.<br><br>2. Tourism in Namibia is proven to provide funds for communities to continue living in their traditional ways. The farm had and still has no traditional families and furthermore cultural attire is not costumes. Tourism on the farm will focus on the ecology and not culture of indigenous groups.<br><br>3. The tourism facility will operate similarly to many of the other facilities in Namibia. There are no sensitive cultural areas within close proximity to the proposed location.<br><br>4. The tourism sector is the fastest growing sector in Namibia and most competitive in the world. It is one of Namibia's most important sectors. The farm and tourism facility will be located on one property. This will ensure resilience and sustainability of the farm and thereby securing sustainable economic benefit and employment. Furthermore the proponent will operate the lodge as per the Namibian Labour Act and other relevant legislation as indicated in the assessment and EMP.<br><br>5. Tourists visit Namibia as tourists and will thus continue to visit tourist establishments and tourist |

| Comments | Responses |
|---|---|
| | attractions. Not developing tourist facilities will not result in tourists coming to Namibia for other purposes. Revenue generated through tourism is taxed and it is the Government's responsibility to responsibly utilize that money to the benefit of all Namibians. |
|     |     |

| Comments | Responses |
|---|---|
| **Revenue Generation and Employment**<br><br>1. "…flow of revenue"..: Although jobs are created, most are relatively low-level. These low-wage, low-skill workers have little prospect for advancement or promotion.<br><br>"…have a positive impact on the economic sphere of the environment…." Here the word environment is not correct, as only the farm owner will benefit!<br><br>"Revenue is generated through the sale of agricultural products on national and international markets." What agricultural products you want to produce, this statement is very brought! | 1. See previous responses for "Increased Crop Yield" |
| **Demographic Profile and Community Health**<br><br>This is paragraph is contradictive to your previous statements about local people and companies, which you will employ and educate! "Farming activities relies on labour. All labourers for the initial agricultural aspects will be housed on site. Similarly all labourers to be employed at the lodge and camping facility will be accommodated on site. No large change in the demographic profile of the local community is thus expected. …….These are typically aggravated with an influx of seasonal workers, and possible foreign construction teams and contractors. An increase in foreign people in the area, linked to unemployment, may potentially increase the risk of criminal and socially / culturally deviant behaviour." None of these potential impacts are directly linked to the project. – Please clarify this statement!!! | This paragraph describes a possible scenario that is typically linked to big developments. These impacts are then dismissed as being applicable to Campbellsdrei. See Section 4.7 regarding labour requirements. As mentioned in Section 10.1.8 all employees will be housed on site. Employed persons will not have a significant impact on the demographic profile of the surrounding community. Kindly note the definition of demographic profile as being the following: Description of the mortality and birth rate, location, age and sex structure of the affected populations. |
| **Traffic**<br><br>1. Campbellsdrei farm has official farm roads, which the owner closed without official consultation of the neighbouring farms. This has to be clarified with all the surrounding farm owners. | There are no servitudes or right of way accesses registered on the property. This was confirmed by the client from the farm's title deed. Unauthorised and uncontrolled access to the property may pose a threat to the proponent and all the workers residing on the farm. It may also increase the chance of poaching and theft. |
| **Fire**<br><br>1. Prepare a holistic fire protection and prevention plan. This plan must include evacuation plans and signage, an emergency response plan and a firefighting plan." The rating score for fire is in the "high risk" range, therefore the owner has to develop, communicate and explain his fire protection and prevention plan with all the surrounding neighbours not only the commercial farmers, before the project might be approved! | 1. Project approval is not subject to the presentation of an emergency response plan and firefighting plan to neighbours. If it is, the same holds true for neighbours having to present such plans to the Proponent. It is in the Proponent's best interest to prevent or quickly deal with possible fires. |
| **Waste Production**<br><br>1. This is just a general statement! " Various waste streams result from the operational and construction / maintenance phases. Waste may include hazardous waste associated with hydrocarbon products and chemicals (fertilisers, pesticides and cleaning products) as well as soil and water contaminated with such products. Construction waste may include building rubble and discarded equipment. Domestic | 1-4. See Section 4.6.3 for a discussion regarding waste and waste handling. It specifically states: "The proponent plans to enter into an agreement with the Stampriet Village Council for disposal of general waste." The proponent is furthermore investigating a biological waste water treatment plant, that, if implemented, is far superior to any of the typical systems used on farms in the area. |

| Comments | Responses |
|---|---|
| and general waste will be generated by the farm and related operations. Waste presents a contamination risk and when not removed regularly may become a health and / or fire hazard and attract wild animals and scavengers." Exact mitigation measures for solid waste as well as for waste water must be stipulated before the EIA/EMP is handed in!<br><br>2. The project includes many entities, each of these entities will have housing and so produce waste and especially waste water. This is a farm and so your statement is not valid: "Liaise with the applicable municipality regarding waste and handling of hazardous waste."<br><br>3. The domestic waste water and the industrial waste water line (for example: vegetables/meat production units) must be separated and if additional pre-cleaning of the industrial waste water must be implemented.<br><br>4. Waste water and sanitation failures are the main reason for communicable diseases in developing countries! | |
| **Change in Soil Characteristics**<br><br>1. "The probability and extent of such an occurrence will be low as the earth dam will serve to accumulate such material, preventing further significant detrimental impacts downstream." Where is this earth dam, I can't find this dam in any of the chapters with the rivers/water on the farm?<br><br>2. If there is a dam on the farm the owner need to have an abstraction permit for the use of the dam water, including the returns for your abstraction permit allowance! This permits and returns needs to be attached to his EIA/EMP, as he started with some of the in this EIA proposed projects. | 1. The earth dam, is the same dam that is referred to in the very first paragraph of the communication received from Dr. Hemberger and Mr. Frey (see top of table). The location of the dam is indicated in Figure 2, page 9 of the report.<br><br>2. The dam's water is not abstracted for any purposes and no permit or returns are thus required for that purpose. |
| **Ecosystem and Biodiversity Impact**<br><br>1. Here more information needs to be provided. This section does not give any information regarding the project as such, it just give some definitions, but it is not clear what crops/vegetables/trees will be planted. Therefore the mitigation measures are also not relevant as such! | 1. The EMP must be used / read in conjunction with the EIA which discussed the crops (section 4) and the local ecology (section 7.8). It is not clear what "definitions" are referred to. |
| **Groundwater and Surface Water Contamination**<br><br>1. Here more information needs to be provided. This section does not give any information regarding the project as such, it just give some indications of the proponent!<br><br>"Chemical spills, inclusive of fertilizers and pesticides, may result in very high but localised contamination of soil, increasing the risk of groundwater contamination if spill clean-up is not performed. Fertilizers and pesticides can leach into the ground and eventually reach and contaminate groundwater. Although the proponent has indicated that organic farming is proposed, the impact assessment considered pesticide application as per the precautionary principle. Excessive fertilizer application can result in greater nitrogen loadings. This is a groundwater pollution risk, especially where the water table is shallow…." | 1. The EMP must be used / read in conjunction with the EIA which discussed the project (section 4).<br><br>2. The legal section refers to the Water Act (1956) that governs effluents. The Water Resources Management Act is not in force yet, but as part of its regulations, the Department of Water Affairs is currently in the process of updating the prescribed effluent standards. These will become applicable once the lodge / tourism part of the project is initiated, since any effluent discharge will then require a permit. The Department of Water Affairs will, together with the permit, provide the conditions and requirements of the effluent treatment system and effluent standards. To stress |

| Comments | Responses |
|---|---|
| "Leakage from sewerage systems may contaminate the groundwater."<br><br>"Action: Maintain sewerage systems and conduct regular monitoring."<br><br>2. There are no specifications on the sewer systems which will be constructed in the different project areas! This is not acceptable, as especially ground water contamination and depletion are posing a high risk for the environment! Specifications has to be added! | the need for this permit, it was added to Section 10.1.1, first bullet point and to 10.1.15. |
| **Groundwater Availability**<br><br>1. " The over abstraction of groundwater for irrigation and other activities may lead to a drop in water table. This may negatively impact on surrounding users as well as existing habitats that depend on groundwater. For example the availability of groundwater may have an impact on the farm and surrounding farms, as well as on a bigger scale due to the cumulative impact. Over abstraction from surrounding users may contribute to the decline in water levels (cumulative impact)."<br><br>Although irrigation has economic advantages, the ground water resources are limited and need to be protected. At study conducted in the Stampriet Transboundary Aquifer System (STAS) indicated that the resources is over-utilized and a 30% reduction in abstraction is necessary to avoid depletion of the ground water around the STAS. To clarify for this EIA:<br><br>2. The Irrigation water allowance is attached, but there is no proof of the returns.<br><br>3. If there is a dam on the farm the proponent need to have a valid abstraction permit for the use of the dam water (which is based on the current size of the dam, the old dam wall was lower, than the recently renovated dam). The permit and returns for your abstraction permit allowance needs also to be attached! This permits and returns needs to be attached to his EIA/EMP, as the proponent started with some of the projects, stated in this EIA already. | 1. Refer to Appendix B, Pg. 63 for the specialist hydrogeological study and its recommendations. Based on the study a cut-off water level was set to prevent over abstraction.<br><br>2. Water abstraction returns are not submitted as part of the EIA, but must be submitted to DWA by the proponent in order to ensure future water permit renewals. Therefore it will be in his best interest to adhere to this requirement.<br><br>3. Dam water is not abstracted or used for irrigation. |
| **Cumulative Impact**<br><br>1. This is a good mitigation measure, if the document will be amended as recommended above:<br><br>" Mitigation:<br><br>Addressing each of the individual impacts as discussed and recommended in the EMP would reduce the cumulative impact.<br><br>Reviewing biannual reports for any new or re-occurring impacts or problems would aid in identifying cumulative impacts. Planning and improvement of the existing mitigation measures can then be implemented" | 1. Noted |

# Appendix F: Consultants' Curriculum Vitae

**Hydrogeologist** **Pierre Botha**

Pierre Botha is the Managing Director of Geo Pollution Technologies, Namibia. Mr. Botha has excellent experience and knowledge in Environmental Impact Assessments, groundwater pollution assessment, groundwater exploration, resource evaluation, urban and rural water supply, groundwater management, monitoring and hydrochemistry. He gained most of his experience in Namibia and is involved in the Namibian groundwater industry since 1992.

Mr Botha's experience in the environmental / groundwater field has been gained from various projects ranging from groundwater exploration, groundwater management and modelling, environmental impact assessments, pollution mapping and rehabilitation to health risk evaluations.

# CURRICULUM VITAE PIERRE BOTHA

| | | |
|---|---|---|
| Name of Firm | : | Geo Pollution Technologies (Pty) Ltd. |
| Name of Staff | : | PIERRE BOTHA |
| Profession | : | Hydrogeologist / Hydrologist<br>Environmental Assessment Practitioner |
| Years' Experience | : | 27 |
| Nationality | : | Namibian |
| Position | : | Managing Director |
| Specialisation | : | Hydrogeology |
| Languages | : | Afrikaans – speaking, reading, writing – excellent<br>English – speaking, reading, writing – excellent |

**EDUCATION AND PROFESSIONAL STATUS:**

| | | |
|---|---|---|
| B.Sc. Geology & Geography | : | University of OFS, 1992 |
| B.Sc. (Hons.)(*cum laude*) Geohydrology/Hydrology | : | University of OFS, 1994 |

| | |
|---|---|
| First Aid Class A | EMTSS, 2017 |
| Basic Fire Fighting | EMTSS, 2017 |

**PROFESSIONAL SOCIETY AFFILIATION:**

Environmental Assessment Professionals of Namibia (EAPAN) – *President 2014 - Vice President 2012, 2013*
Hydrogeological Association of Namibia (HAN)
Geological Association of Namibia

**AREAS OF EXPERTISE:**

Knowledge and expertise in:

- risk based corrective action analyses
- bioremediation
- monitoring, mapping and evaluation of groundwater pollution
- hydrochemistry studies
- environmental impact assessments
- project management
- soil vapour surveys
- groundwater modelling
- groundwater monitoring
- hydrocensus
- hydrogeological data evaluation and interpretation
- groundwater exploration and resource evaluation
- geophysical interpretations (Ground Penetrating Radar, Electrical Resistivity, Electromagnetic & Magnetic)
- urban and rural water supply
- groundwater management
- borehole siting, drilling and test pumping supervision, aquifer testing

**EMPLOYMENT:**

| | | |
|---|---|---|
| 1998-Date | : | Geo Pollution Technologies (Pty) Ltd |
| 1995 | : | Parkman Namibia (Groundwater Consulting Services) - Hydrogeologist |
| 1994 | : | Institute for Groundwater Studies, University of the Orange Free State - Hydrogeologist |
| 1992-1993 | : | Groundwater Consulting Services - Field Geologist |
| 1988 | : | Tsumeb Corporation Ltd - Student geologist |

**PUBLICATIONS:**

| | |
|---|---|
| Contract reports | : +400 |
| Publications | : 1 |

**ENVIRONMENTAL SCIENTIST** **André Faul**

André entered the environmental assessment profession at the beginning of 2013 and since then has worked on more than 120 Environmental Impact Assessments including assessments of the petroleum industry, harbour expansions, irrigation schemes, township establishment and power generation and transmission. André's post graduate studies focussed on zoological and ecological sciences and he holds a M.Sc. in Conservation Ecology and a Ph.D. in Medical Bioscience. His expertise is in ecotoxicological related studies focussing specifically on endocrine disrupting chemicals. His Ph.D. thesis title was The Assessment of Namibian Water Resources for Endocrine Disruptors. Before joining the environmental assessment profession he worked for 12 years in the Environmental Section of the Department of Biological Sciences at the University of Namibia, first as laboratory technician and then as lecturer in biological and ecological sciences.

# CURRICULUM VITAE ANDRÉ FAUL

| | | |
|---|---|---|
| Name of Firm | : | Geo Pollution Technologies (Pty) Ltd. |
| Name of Staff | : | ANDRÉ FAUL |
| Profession | : | Environmental Scientist |
| Years' Experience | : | 17 |
| Nationality | : | Namibian |
| Position | : | Environmental Scientist |
| Specialisation | : | Environmental Toxicology |
| Languages | : | Afrikaans – speaking, reading, writing – excellent<br>English – speaking, reading, writing – excellent |

**EDUCATION AND PROFESSIONAL STATUS:**

| | | |
|---|---|---|
| B.Sc. Zoology | : | University of Stellenbosch, 1999 |
| B.Sc. (Hons.) Zoology | : | University of Stellenbosch, 2000 |
| M.Sc. (Conservation Ecology) | : | University of Stellenbosch, 2005 |
| Ph.D. (Medical Bioscience) | : | University of the Western Cape, 2018 |

| | |
|---|---|
| First Aid Class A | EMTSS, 2017 |
| Basic Fire Fighting | EMTSS, 2017 |

**PROFESSIONAL SOCIETY AFFILIATION:**

Environmental Assessment Professionals of Namibia (Practitioner and Committee Member)

**AREAS OF EXPERTISE:**

Knowledge and expertise in:

- Water Sampling, Extractions and Analysis
- Biomonitoring and Bioassays
- Biodiversity Assessment
- Toxicology
- Restoration Ecology

**EMPLOYMENT:**

| | | |
|---|---|---|
| 2013-Date | : | Geo Pollution Technologies – Environmental Scientist |
| 2005-2012 | : | Lecturer, University of Namibia |
| 2001-2004 | : | Laboratory Technician, University of Namibia |

**PUBLICATIONS:**

| | |
|---|---|
| Publications: | 5 + 1 in preparation |
| Contract Reports | +120 |
| Research Reports & Manuals: | 5 |
| Conference Presentations: | 1 |

**ENVIRONMENTAL ASSESSMENT PRACTITIONER** **Quzette Bosman**

Quzette Bosman has 11 years' experience in the Impact Assessment Industry, working as an Environmental Assessment Practitioner and Social Assessment practitioner mainly as per the National Environmental Legislation sets for South Africa and Namibia. Larger projects have been completed in terms of World Bank and IFC requirements. She studied Environmental Management at the Rand Afrikaans University (RAU) and University of Johannesburg (UJ), including various Energy Technology Courses. This has fuelled a passion towards the Energy and Mining Industry with various projects being undertaken for these industries. Courses in Sociology has further enabled her to specialize in Social Impact Assessments and Public Participation. Social Assessments are conducted according to international best practise and guidelines. Work has been conducted in South Africa, Swaziland and Namibia.

# CURRICULUM VITAE QUZETTE BOSMAN

| | | |
|---|---|---|
| Name of Firm | : | Geo Pollution Technologies (Pty) Ltd. |
| Name of Staff | : | QUZETTE BOSMAN |
| Profession | : | Social Impact Assessor / Environmental Assessment Practitioner |
| Years' Experience | : | 8 |
| Nationality | : | South African |
| Position | : | Senior Environmental Consultant |
| Specialisation | : | ESIA & ESMP; SIA |
| Languages | : | Afrikaans – speaking, reading, writing – excellent<br>English – speaking, reading, writing – excellent |

**EDUCATION AND PROFESSIONAL STATUS:**

| | | | |
|---|---|---|---|
| BA | Geography & Sociology | : | Rand Afrikaans University, 2003 |
| BA | (Hons.) Environmental Management | : | University of Johannesburg, 2004 |

| | |
|---|---|
| First Aid Class A | EMTSS, 2017 |
| Basic Fire Fighting | EMTSS, 2017 |

**PROFESSIONAL SOCIETY AFFILIATION:**

Namibian Environment and Wildlife Society
International Association of Impact Assessors South Africa (IAIA SA)
Member 2007 - 2012
Mpumalanga branch Treasurer 2008/2009

OTHER AFFILIATIONS
Mkhondo Catchment Management Forum (DWAF): Chairperson 2008-2010
Mkhondo Water Management Task Team (DWAF): Member 2009

**AREAS OF EXPERTISE:**

Knowledge and expertise in:

- environmental impact assessments, social impact assessment and social management planning
- project management
- community liaison, social monitoring, public participation / consultation
- social risk management
- water use licensing
- environmental auditing and compliance, environmental monitoring
- strategic environmental planning

**EMPLOYMENT:**

| | | |
|---|---|---|
| 2015 - Present | : | Geo pollution Technologies – Senior Environmental Practitioner |
| 2014-2015 | : | Enviro Dynamics – Senior Environmental Manager |
| 2010 - 2012 | : | GCS – Environmental Manager (Mpumalanga Office Manager) |
| 2007 - 2009 | : | KSE-uKhozi - Technical Manager: Environmental |
| 2006 -2007 | : | SEF – Environmental Manager |
| 2004 - 2005 | : | Ecosat – Environmental Manager |

**PUBLICATIONS:**

| | |
|---|---|
| Contract reports | : +150 |
| Publications | :1 |

**HYDROGEOLOGIST** **Jannie van der Merwe**

Jannie van der Merwe holds an honours degree in hydrology and geohydrology from the Northwest-University Potchefstroom (NWU) South Africa. He first completed a B.Sc. degree in Geology and Geography in the required time also from the Northwest University Potchefstroom South Africa.

His honours project entailed Preparing Groundwater Resource Directed Measures for Catchment: J21A Beaufort West in South Africa. In his honours year he also completed an advanced course in ArcMap (GIS). He started working at Geo Pollution Technologies at the beginning of 2016 and he regularly conducts or assists in soil vapour surveys, groundwater monitoring and sampling, soil sampling, tank pit surveys, geophysics (borehole siting), hydrocensus studies, pump testing and groundwater specialist studies.

## CURRICULUM VITAE JANNIE VAN DER MERWE

| | | |
|---|---|---|
| Name of Firm | : | Geo Pollution Technologies (Pty) Ltd. |
| Name of Staff | : | JANNIE VAN DER MERWE |
| Profession | : | Hydrogeologist |
| Nationality | : | Namibian |
| Position | : | Environmental Scientist |
| Specialisation | : | Groundwater, Geology |
| Languages | : | Afrikaans – speaking, reading, writing<br>English – speaking, reading, writing |

**EDUCATION AND PROFESSIONAL STATUS:**

| | | |
|---|---|---|
| B.Sc. Geology and Geography | : | Northwest University (NWU) 2014 |
| B.Sc. (Hons.) Hydrology and Geohydrology | : | Northwest University (NWU) 2015 |
| First Aid Class A | | EMTSS, 2017 |
| Basic Fire Fighting | | EMTSS, 2017 |

**AREAS OF EXPERTISE:**

Knowledge and expertise in:

- Groundwater
- Geology
- Geophysics
- Basic Geographic Information Skills (ArcGIS, Manifold)

**EMPLOYMENT:**

2016 - Date : Geo Pollution Technologies – Environmental Scientist

**PUBLICATIONS:**

Contract Reports: +30