SCOPING (INCLUDING IMPACT ASSESSMENT) FOR ACTIVITIES ASSOCIATED WITH GALORE TRADING'S HORTICULTURE IRRIGATION PROJECT, LOCATED ±2 KM EAST OF ORANJEMUND TOWN, //KARAS REGION, NAMIBIA

OCTOBER 2022

EXPERTISE AND DECLARATION OF INDEPENDENCE

I.N.K Enviro Consultants cc is the independent firm of consultants that has been appointed by Galore Trading cc to undertake the environmental impact assessment process.

Immanuel N. Katali, the EIA Lead Practitioner holds a B.Arts (Honors) in Geography, Environmental Studies and Sociology and has over 5 years experience in conducting EIAs in Namibia.

The consultant herewith declare that this report represents an independent, objective assessment of the environmental impacts associated with the activities of the proposed horticulture irrigation project.

EXECUTIVE SUMMARY

Galore Trading cc (hereinafter referred to as Galore), intends to construct and operate a horticulture irrigation project, located ±2 km southeast of Oranjemund, on two bordering agricultural plots, made available by the Oranjemund Town Council and measuring a total of 64 hectares (ha). The project aims to produce fruits and vegetables (onion, tomato, green pepper, carrot, pumpkins and cabbage) in the early stages and expand to various other crops in the future, pending further suitability investigations.

This Environmental Impact Assessment (EIA) Scoping (including impact assessment) Report has been compiled and was be distributed for a two-week (14 days) review and comment as part of the EIA process that is being undertaken for the proposed Horticulture Irrigation Project.

Registered Interested and Affected Parties (IAPs) are being provided with the opportunity to comment on this Scoping (including impacts assessment) Report. Once the comment period closes, the Report will be updated to a final report with due consideration of the comments received, and will be submitted to the Ministry of Environment, Forestry and Tourism (MEFT) for decision-making.

This proposed project follows the footsteps of the Government of Namibia's aims and objectives to ensure agriculture productivity and food security as part of the Green Scheme Policy, "to maximise irrigation opportunities for agriculture productivity and social development around wetlands" and in line with Vision 2030 strategy.

The //Karas Region is in south-western Namibia and is known for agricultural, mining and tourism activities as the main economic drive. The proposed horticulture project is located adjacent to the Transboundary Water Resources (Orange River), currently shared by four individual countries (for their own water resources within their counties). The four countries referred to herein are; Namibia, South Africa, Lesotho and Botswana. This site is located in an area known as the Orange River Mouth Ramsar Site. These are sites selected worldwide to help protect wetlands of international importance.

There has been a large demand for local produce in the market. The proposed project will therefore ensure:

- An increase in the tax base of the economy;
- An increase in the development of jobs, and skills, in the labour sector; and
- An increase in the production, and supply of crops in the local market (a commodity which is currently in high demand).

The challenge facing the project proponent is its contribution towards achieving these goals while at the same time preventing and/or mitigating potential negative social and environmental impacts.

RECOMMENDATIONS

The consultation process with key stakeholders that included government authorities and I&APs allowed the opportunity to raise the issues associated with the project development. It was identified that; the following aspects will need to be further assessed:

- Groundwater and Surface Water;
- Noise Pollution
- Visual Impact
- Waste Management
- Socio-economic
- Biodiversity

The relevance of the potential impacts ("screening") are also presented in the tables below to determine aspects to be assessed in further detail (Section 8 of this report). The relevant mitigation measures have been included in the Environmental Management Plan, which Galore has to adhere to for the lifetime of the project.

CONCLUSIONS

Overall, the development of the Oranjemund Irrigation Project would have a positive impact on the local community and economy as well as on the Namibian economy as a whole. In addition, the project would provide an invaluable contribution to food security in Namibia as a whole.

It was concluded from the assessments that construction and operational impacts would have minimal impact on air quality, noise levels, visual characteristics and heritage artefacts. Socio-economics were deemed to be positively impacted both directly and indirectly from both construction and operations at the site, but some negative impacts were identified, such as the in-migration of people into the town. The employment and skills development of local people is recommended.

Furthermore, the project alone should not have a significant impact on the abstraction from the Orange River, however, these calculations do not take into account any other planned abstraction along the river, which could affect the amounts of available water. The cumulative effects arising from the abstraction of water from the Orange River is not assessed and part of this study.

Mitigation measures have been identified and recommended both by the specialist assessment and by I.N.K Enviro Consultants cc to promote the positive impacts of the project, as well as to reduce the negative impacts to acceptable levels. An EMP was further developed which identifies potential impacts

of the project during the construction and operation phases. The EMP is a legally binding document, which Galore and contractors onsite must adhere to.

I.N.K concludes that should Galore follow the actions (i.e. management and mitigation measures) provided in the EIA and EMP report, the project would have an acceptable impact on the surrounding physical and social environment.

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LIST OF ACRONYMS, ABBREVIATIONS AND UNITS

Acronym / Abbreviation	Definition
EAPAN	Environmental Assessment Professionals of Namibia
ECC	Environmental Clearance Certificate
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
GAP	Good Agriculture Practice
IAPS	Interested and Affected Parties
MAWLR	Ministry of Agriculture, Water and Land Reform
MEFT	Ministry of Environment, Forestry and Tourism
PPP	Public Participation Process

1 INTRODUCTION

This section discusses the aims and objectives of the study and provides a brief introduction on the proposed horticulture irrigation activities.

1.1 Objectives of the Study and Opportunity to Comment

This Environmental Impact Assessment (EIA) Scoping (including impact assessment) Report has been compiled and was distributed for a two-week (14 days) review and comment as part of the EIA process that has been undertaken for the proposed Horticulture Irrigation Project.

This Scoping (including impacts assessment) Report summarises the EIA process being followed and provides an overview of the affected environment. It includes the findings of the specialist studies, an assessment of the environmental impacts that the proposed activities are likely to have and sets out the consultants' recommendations. The proposed management and mitigation measures (including measures for the existing and operational irrigation scheme) relating to the proposed activities are documented in an Environmental Management Plan (EMP).

Registered Interested and Affected Parties (IAPs) were provided with the opportunity to comment on this Scoping (including impacts assessment) Report (see Section 2). Once the comment period closed, the Report was updated to a final report with due consideration of the comments received, and was submitted to the Ministry of Environment, Forestry and Tourism (MEFT) for decision-making.

1.2 Introduction to the Proposed Project

Galore Trading cc (hereinafter referred to as Galore), intends to construct and operate a horticulture irrigation project, located ±2 km southeast of Oranjemund, on two bordering agricultural plots, made available by the Oranjemund Town Council and measuring a total of 64 hectares (ha) (Figure 1). The project aims to produce fruits and vegetables (onion, tomato, green pepper, carrot, pumpkins and cabbage) in the early stages and expand to various other crops in the future, pending further suitability investigations.

The water for the irrigation project is proposed to be abstracted from the Orange River (located ±1 km east of the project site) to the irrigation site via underground pipeline and with the use booster pumps near the river. Bulk irrigation water will be piped from the river to a series of booster pump stations located on the project area to supply the various irrigation systems. The irrigation project aims to abstract water from the Orange River of approximately 1.2 million m^3/annum. A water abstraction permit was submitted to the Department of Water Affairs. A hydrogeology Specialist Study was conducted as part of this EIA (see annexure).

This proposed project follows the footsteps of the Government of Namibia's aims and objectives to ensure agriculture productivity and food security as part of the Green Scheme Policy, "to maximise irrigation opportunities for agriculture productivity and social development around wetlands" and in line with Vision 2030 strategy.

Prior to commencement of any construction activities of the proposed project, an Environmental Clearance Certificate (ECC) is required on the basis of an approved Environmental Impact Assessment (EIA) and Environmental Management Plan (EMP). It is with this background that, I.N.K Enviro Consultants cc (I.N.K) an independent firm of consultants, was appointed to undertake the Environmental Impact Assessment process for this project. More details regarding the EIA process that was followed are presented in Section 1.4.

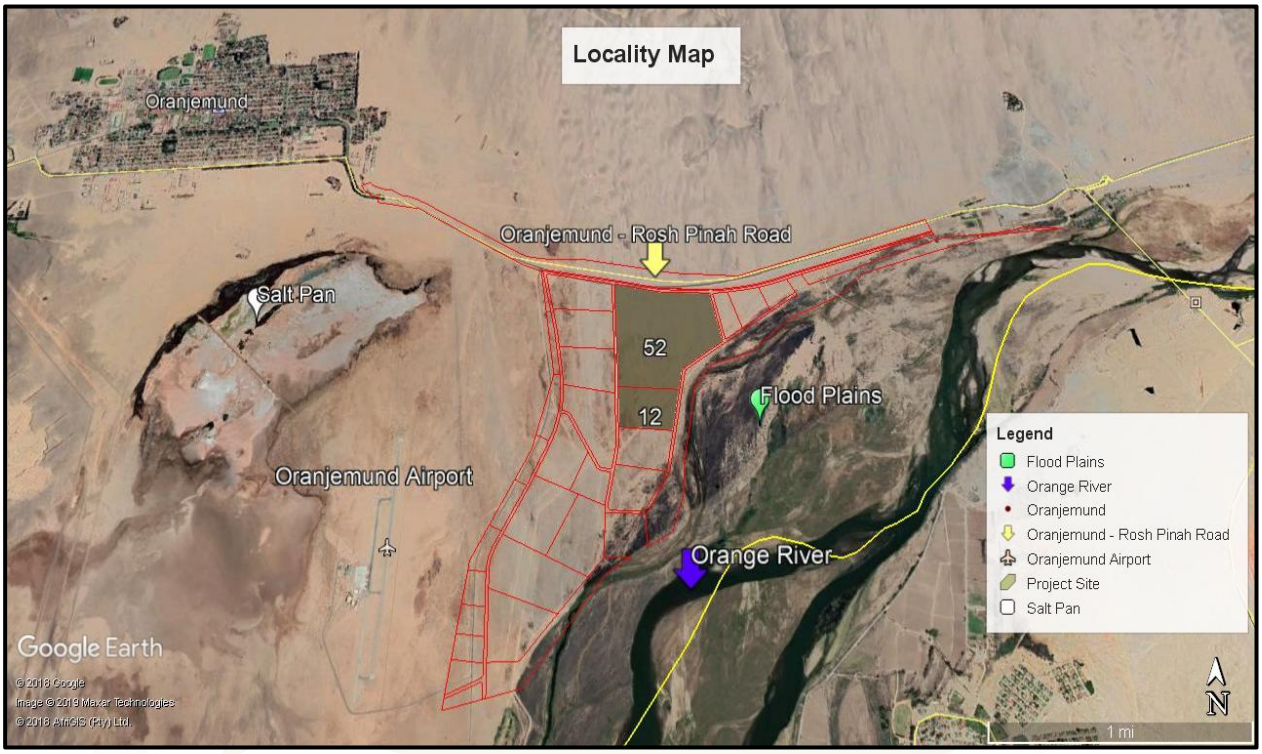

Figure 1: Location of the Proposed Horticulture Irrigation Project

The //Karas Region is in south-western Namibia and is known for agricultural, mining and tourism activities as the main economic drive. The proposed horticulture project is located adjacent to the Transboundary Water Resources (Orange River), currently shared by four individual countries (for their own water resources within their counties). The four countries referred to herein are; Namibia, South Africa, Lesotho and Botswana. This site is located in an area known as the Orange River Mouth Ramsar Site. These are sites selected worldwide to help protect wetlands of international importance.

1.3 Project Motivation (Need and Desirability)

This proposed project follows the footsteps of the Government of Namibia's aims and objectives to ensure agriculture productivity and food security as part of the Green Scheme Policy and in line with Vision 2030 strategy. The Green Scheme is designed to maximise irrigation opportunities along the maize triangle (Grootfontein, Tsumeb and Otavi) as well as in the North Central and North Eastern

regions using the Kunene, Kavango and Zambezi rivers as well as the promotion of agro projects in the South using Orange River and dams such as Naute and Hardap. This policy aims at harnessing the resources of Government and other stakeholders in order to increase agriculture productivity and social development as envisaged in NDP III and Vision 2030 strategy.

Furthermore, there has been a large demand for local produce in the market. The proposed project will therefore ensure:

- An increase in the tax base of the economy;
- An increase in the development of jobs, and skills, in the labour sector; and
- An increase in the production, and supply of crops in the local market (a commodity which is currently in high demand).

The challenge facing the project proponent is its contribution towards achieving these goals while at the same time preventing and/or mitigating potential negative social and environmental impacts.

1.4 Introduction to the Environmental Impact Assessment

Environmental Impact Assessments are regulated by the Ministry of Environment and Tourism (MET) in terms of the Environmental Management Act, 7 of 2007. This Act was gazetted on 27 December 2007 (Government Gazette No. 3966) and enacted on 6 February 2012. The Environmental Impact Assessment Regulations: Environmental Management Act, 2007 (Government Gazette No. 4878) were promulgated on 6 February 2012.

1.4.1 EIA Process

Table 1: EIA Process

Objectives	Corresponding activities
Project initiation and Screening phase	
• Initiate the screening process • Initiate the environmental impact assessment process.	• Site Visit • Identify Key Stakeholders • Early identification of environmental aspects and potential impacts associated with the proposed project.
EIA Phase with combined Scoping and Assessment	
• Notify the decision-making authority of the proposed project • Identify interested and/or affected parties (IAPs) and involve them in the scoping process through information sharing. • Identify potential environmental issues associated with the	• Written notification submitted to MET. • Notify government authorities and IAPs of the project and EIA process (telephone calls, e-mails, faxes, newspaper advertisements and site notices).

proposed project. • Consider alternatives. • Identify any fatal flaws. • Determine the terms of reference for additional assessment work.	
Assessment and EMP Compilation Reports	
• Provide a detailed description of the potentially affected environment. • Assessment of potential environmental impacts. • Design requirements and management and mitigation measures. • Receive feedback on application.	• Investigations by technical project team and appointed specialist. • Compilation of draft EIA and EMP reports. • Distribute draft EIA and EMP reports to authorities and IAPs for review. • Forward the final draft EIA and EMP reports and IAPs comments to MET for review. • MET review and Record of Decision.

Within this framework, the required components of the EIA report are discussed in more detail as part of the EIA methodology in Section 8.

EIAs are influenced by national legislation and a range of guidelines. The legislation applicable to this project and the EIA process is discussed further in Section 3 below.

1.4.2 EIA Team

I.N.K Enviro Consultants cc is the independent firm of consultants that has been appointed by Galore Trading cc to undertake the environmental impact assessment and related processes.

Immanuel N. Katali, the EIA project manager holds a B.Arts (Honours) Degree in Geography, Environmental Studies and Sociology and has over five years of relevant experience in conducting/managing EIAs, compiling EMPs. Immanuel is certified as an environmental practitioner under the Environmental Assessment Professionals Association of Namibia (EAPAN).

Ms. Miller Mwashidange, the assistant environmental assessment practitioner holds a B.Arts (Honours) Degree in Geography, Environmental Studies and Sociology and MEng. Science and Technology of Mapping and Surveying, obtained from the China University of Geoscience (Beijing).

Ms. Fredrika Shagama, the project Hydrogeology Specialist has over five years of experience and holds a BSc. Geological Engineering, and MSc. Geological Engineering (cum laude) with primary focus in Hydrogeology, obtained from VSB - Technical University of Ostrava, Czech Republic

2 SCOPING METHODOLOGY

2.1 Information collection

I.N.K used various information sources to identify and assess the issues associated with the proposed project. These include:

- Site visits by I.N.K;
- Consultation with Project Technical Team (Galore) and relevant information shared by Galore;
- Consultation with MET via online application system;
- Consultation with I&APs and the Oranjemund Municipality;
- Atlas of Namibia;
- Google Earth; and
- Internet sources.

2.2 Scoping Report

The main purpose of this Scoping Report is to indicate which environmental aspects relating to the proposed project might have an impact on the environment, to assess them and to provide management and mitigation measures to avoid or minimise these impacts.

Table 2 outlines the Scoping Report requirements as set out in Section 8 of the Environmental Impact Assessment Regulations that were promulgated in February 2012 in terms of the Environmental Management Act, 7 of 2007.

Table 2: Scoping report Requirements stipulated in the EIA regulations

Requirements for a Scoping Report in terms of the February 2012 regulations	Reference in report
(a) the curriculum vitae of the EAPs who prepared the report;	Section 1.4.2 and Appendix A
(b) a description of the proposed activity;	Section 4
(c) a description of the site on which the activity is to be undertaken and the location of the activity on the site;	Sections 4 & 6
(d) a description of the environment that may be affected by the proposed activity and the manner in which the geographical, physical, biological, social, economic and cultural aspects of the environment may be affected by the proposed listed activity;	Sections 6, 7 and 8
(e) an identification of laws and guidelines that have been considered in the preparation of the Scoping Report;	Section 3
(f) details of the public consultation process conducted in terms of regulation 7(1) in connection with the application, including - (i) the steps that were taken to notify potentially interested and affected parties of the proposed application;	Sections 2.3, 2.4, 2.5 and Appendix B & E

(ii) proof that notice boards, advertisements and notices notifying potentially interested and affected parties of the proposed application have been displayed, placed or given; (iii) a list of all persons, organisations and organs of state that were registered in terms of regulation 22 as interested and affected parties in relation to the application; and (iv) a summary of the issues raised by interested and affected parties, the date of receipt of and the response of the EAP to those issues;	
(g) a description of the need and desirability of the proposed listed activity and any identified alternatives to the proposed activity that are feasible and reasonable, including the advantages and disadvantages that the proposed activity or alternatives have on the environment and on the community that may be affected by the activity;	Sections 1.3 and 5
(h) a description and assessment of the significance of any significant effects, including cumulative effects, that may occur as a result of the undertaking of the activity or identified alternatives or as a result of any construction, erection or decommissioning associated with the undertaking of the proposed listed activity;	Sections 7 and 8
(i) terms of reference for the detailed assessment; and	Section 7 & 8
(j) a management plan, which includes - (i) information on any proposed management, mitigation, protection or remedial measures to be undertaken to address the effects on the environment that have been identified including objectives in respect of the rehabilitation of the environment and closure; (ii) as far as is reasonably practicable, measures to rehabilitate the environment affected by the undertaking of the activity or specified activity to its natural or predetermined state or to a land use which conforms to the generally accepted principle of sustainable development; and (iii) a description of the manner in which the applicant intends to modify, remedy, control or stop any action, activity or process which causes pollution or environmental degradation remedy the cause of pollution or degradation and migration of pollutants.	Appendix F

2.3 Public Participation Process

The public participation process for the proposed project is conducted to ensure that all persons and/or organisations that may be affected by, or interested in the proposed project, were informed of the project and could register their views and concerns. By consulting with relevant authorities and I&APs,

the range of environmental issues to be considered in this Scoping Report (including the assessment of impacts) has been given specific context and focus.

Included below is a summary of the I&APs consulted, the process that was followed and the issues that were identified.

2.4 Horticulture Irrigation Project I&APs

The following table (Table 3) provides a list of persons, group of persons or organisations that were informed about the project and were requested to register as I&APs should they be interested and/or affected.

Table 3: Oranjemund Irrigation Project Stakeholders

IAP Grouping	Organisation
Government Ministries	▪ Ministry of Environment and Tourism (MET); • Department of Environmental Affairs (DEA). ▪ Ministry of Agriculture, Water and Land Reform; • Department of Water Affairs
Local Governance	The Oranjemund Municipality
Residents	Oranjemund Residents
Media	Newspaper adverts: Die Republikein and The Namibian Sun
Other interested and affected parties	Any other people with an interest in the proposed project or who may be affected by the proposed project.

2.5 Steps in the consultation process

Table 4 sets out the steps that were followed as part of the consultation process:

Table 4: Consultation process with I&APs and Authorities

TASK	DESCRIPTION
Notification to MET	I.N.K submitted the Application Form (online system) to MET.
IAP identification	A stakeholder database was developed for the proposed project and EIA process. Additional I&APs will be updated during the EIA process as required.
Distribution of background information	BIDs were made available to all I&APs on the project's stakeholder database and were available at the scoping meetings. Copies of the BID were available on request to

TASK	DESCRIPTION
document (BID)	I.N.K. The purpose of the BID was to inform I&APs and authorities about the proposed project, the EIA process, possible environmental impacts and means of providing input into the EIA process. Attached to the BID was a registration and response form, which provided I&APs with an opportunity to submit their names, contact details and comments on the project.
Site notices	A site notice was placed on the irrigation designated plot. Refer Appendix D for a copy of the site notice..
Newspaper Advertisements	Block advertisements were placed as follows: ▪ Die Republikein (16 and 23 June 2019) ▪ The Namibian Sun (16 and 23 June 2019)
Scoping Meetings	Several consultations were made with I&APs. This included meetings and telephonic conversations. Focus group meetings were held with key stakeholders and affected parties as follows: ▪ Oranjemund Town Council on 1 July 2019 A public meeting was held on the 1st of July at the Zacharias Lewala Community Hall in Oranjemund Town. The same project information was presented/shared at all meetings.
Comments and Responses	Minutes of the meetings have been taken. A Summary Issues and Response Report has been compiled.
IAPs and authorities (excluding MEFT:DEA) review of Scoping Report and updated EMP	The Scoping Report (Main Report excluding Appendices) were sent via email to all parties who registered or showed an interest in this EIA process. Electronic copies of the full report (including appendices) will be made available on request to I.N.K. A Hard copy is made available at the Oranjemund Town Council for public review. Authorities and IAPs have 14-working days to review the Scoping Report and submit comments in writing to I.N.K. The closing date for comments is 8 July 2021.

TASK	DESCRIPTION
MEFT review of Scoping Report and EMP	A copy of the final Scoping Report, including authority and I&AP review comments, will be submitted to MET on completion of the public review process via the online application system.

2.6 Summary of issues raised

All issues that have been raised to date by authorities and IAPs have been recorded. Below is a summary of the key issues raised:

- Orange River Water Abstraction and Quantity;
- Impacts on wild animals;

3 ENVIRONMENTAL LAWS AND POLICY

This section discusses and describes the governing laws, policies and acts that are relevant to the environmental impact assessment for the proposed Horticulture Irrigation Project.

The Republic of Namibia has five tiers of law and a number of policies relevant to environmental assessment and protection, which includes:

- The Constitution
- Statutory law
- Common law
- Customary law
- International law

Key policies currently in force include:

- The EIA Policy (1995).
- Namibia's Environmental Assessment Policy for Sustainable Development and Environmental Conservation (1994).

As the main source of legislation, the Constitution of the Republic of Namibia (1990) makes provision for the creation and enforcement of applicable legislation. In this context and in accordance with its constitution, Namibia has passed numerous laws intended to protect the natural environment and mitigate against adverse environmental impacts.

3.1 Applicable Laws and Policies

In the context of the proposed irrigation project, there are several laws and policies currently applicable. They are reflected in Table 5 below.

Table 5: RELEVANT LEGISLATION AND POLICIES

YEAR	NAME	Natural Resource Use (energy & water)	Emissions to air (fumes, dust & odours)	Emissions to land (non-hazardous & hazardous	Emissions to water (industrial & domestic)	Noise	Visual	Impact on Land use	Impact on biodiversity	Impact on Archaeology	Socio-economic	Safety & Health
1990	The Constitution of the Republic of Namibia of 1990	X	X	X	X	X	X	X	X	X	X	X
1997	Namibian Water Corporation Act, 12 of 1997	X									X	
2001	The Forestry Act 12 of 2001	X						X	X			
2013	Water Resources Management Act 11 of 2013	X			X						X	
2004	National Heritage Act 27 of 2004									X		X

2007	Environmental Management, Act 7 of 2007	X	X	X	X	X	X	X	X	X	X	X
2012	Regulations promulgated in terms of the Environmental Management, Act 7 of 2007											
1975	Nature Conservation Ordinance 14 of 1975	X			X				X	X		
1976	Atmospheric Pollution Prevention Ordinance 11 of 1976		X									
1995	Namibia's Environmental Assessment Policy for Sustainable Development and	X	X	X	X	X	X	X	X	X		X

	Environmental Conservation	
2008	Green Scheme Policy	X
1995	National Agricultural Policy	X
2003	Agricultural (Commercial) Land Reform Amendment Act	X

4 Project Description

This section discusses and describes the proposed horticulture irrigation project and associated activities.

4.1 Introduction

The proposed Horticulture Irrigation Project is located ±2 km east of Oranjemund, adjacent to the Rosh Pinah – Oranjemund road. The total area to be covered by the irrigation activities is ±64 ha. The project area lies on the flood plain of the Orange River, consisting of wetland vegetation spreading over most of the site and home to a number of wildlife such as springbok, gemsbok, ostrich, jackals and wild horses.

The horticulture crops that will be farmed and sold commercially, includes; onion, tomato, green pepper, carrot, pumpkins and cabbage.

4.1 Existing Infrastructure

The proposed project is on two bordering plots, designated by the Oranjemund Town Council. There is currently no other existing infrastructure except for the Rosh Pinah-Oranjemund road, located north of the project site. However, no permanent structures will be constructed on site.

4.2 Construction Activities

4.2.1 Construction of Storage Facilities

The food storage facility will be constructed on a separate piece of land and does not form part of this EIA process. However, the storage facility for equipment and tools will be constructed on site using temporary structures. No permanent structures will be constructed on site.

4.2.2 Land Clearing

The main construction-related activity will be the clearing of land for the establishment of the irrigation scheme. Roughly 60 ha of clearing is required to clear the proposed field areas of vegetation.

4.2.3 Water reticulation

Construction activities associated with the water reticulation will include:

- Installation of the river pump station;
- Clearing pipeline routes of vegetation;
- Cutting trenches for installation of pipelines;
- Placing and joining pipeline segments;
- Construction of booster pump stations:
    - Clearing;
    - Laying foundations;
    - Building construction;
    - Installation of pumps;
- Installation of drip irrigation systems.

4.2.4 Electrical distribution/Power Supply

Power will be supplied using underground electricity cables to the site from the existing Golf Course Substation located near the site (refer to Figure 2).

The construction of the electrical distribution system will involve:

- Clearing routes for underground power lines;
- Installation of single metering connection point;
- Excavation of trenches for underground power lines.

All sub-surface cable lines will be dug-in at a minimum depth of 1.2 m with danger tape placed at 1 m below ground. This precaution will prevent cable damage by harvesters or other agricultural machinery, even during deep ripping activities for soil preparation. Where machine traffic is expected special caution will be taken in lifting power lines to ensure vehicle and occupant safety.

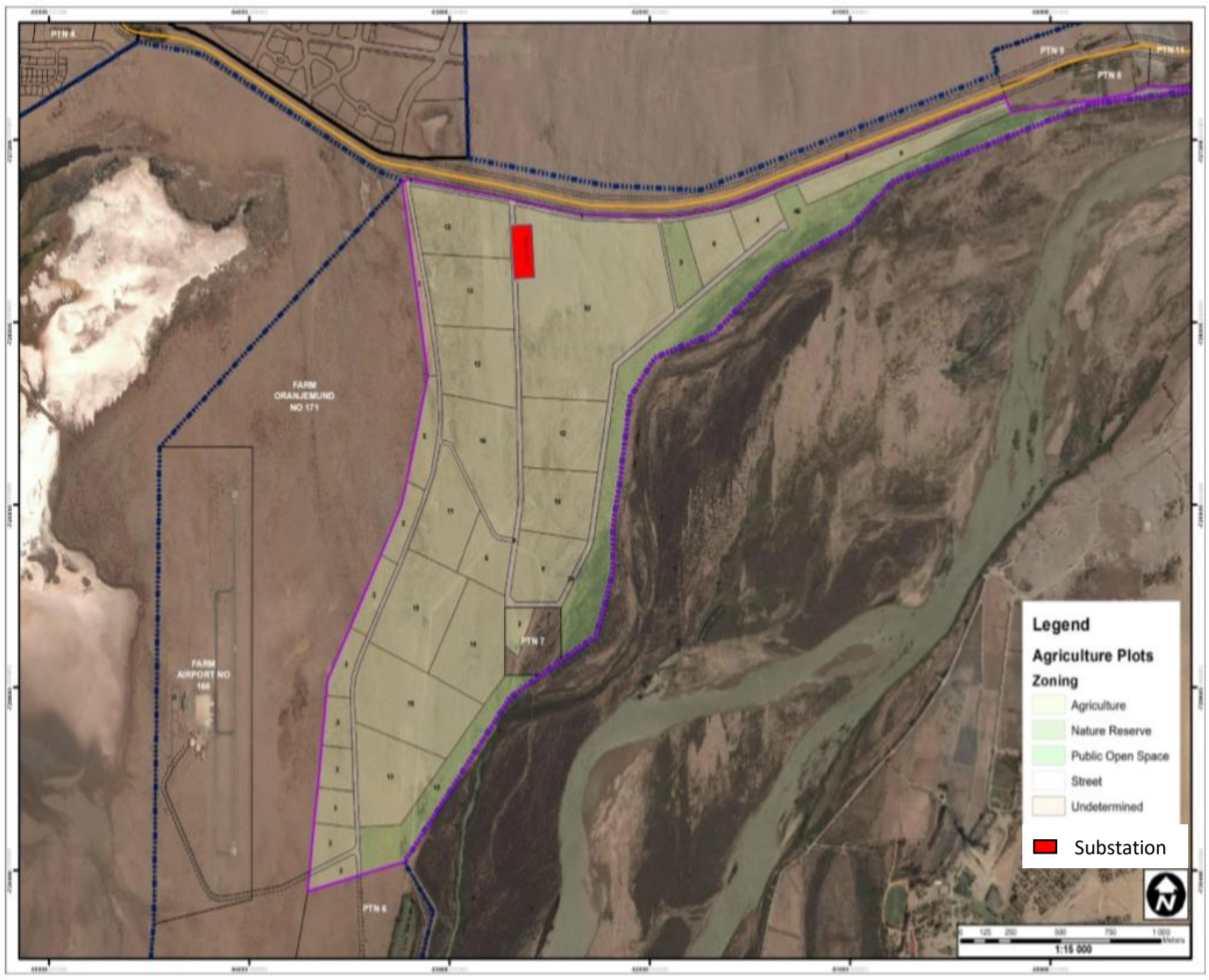

Figure 2: Substation Location

4.2.5 Fences

Due to the presence of wild animals in the surrounding areas, the irrigation fields need to be effectively fenced off. A stock-proof fence is required to prevent entry of animals as well as unauthorized people.

4.2.6 Transport routes/Access

The horticulture irrigation project is located ±2 km southeast of Oranjemund, taking either the Rosh Pinah-Oranjemund road or the Oranjemund airport road for ±1.5 km southeast of Oranjemund. The transportation route will follow the same scenario. The proposed project is located along paths of existing gravel roads. No new roads will be constructed.

4.2.7 Timetable

The construction process is expected to be initiated as soon as the MEFT issues the Environmental Clearance Certificate and all other relevant authorisation have been obtained and will take ±4 months to complete.

4.2.8 Construction Staff

The construction phase will employ ±50 people over a period of 4 months.

The construction workforce/contractors will commute to the designated sites each day during the construction phase and will be accommodated in Oranjemund. No accommodation or any permanent structures will be constructed on site.

4.3 Operational Activities

4.3.1 Water Supply

The irrigation project aims to abstract water from the Orange River of approximately 1 million m^3/annum. A water abstraction permit will be submitted to the Department of Water Affairs and Forestry (DAWF).

Water supply will be required and abstracted from the Orange River by the use of a low pressure pipeline that will be constructed and supported by a single river abstraction pump station. At river source, a bulk supply river pump station will be installed. This river pump station is located at the river ±1 km from the irrigation site.

Besides the water needed for crop irrigation, water is also required for general use, e.g. drinking water, washing and cleaning, etc. (included in above-mentioned volumes).

4.3.2 Pipelines

The irrigation water will be transferred via a large diameter low pressure pipeline of ±1 km to a booster pump station from which the bulk water is distributed to the various irrigation systems at the required pressure.

4.3.3 Pipeline Distribution Network

A network of smaller-diameter pipelines will distribute irrigation water from the booster pump station to the individual irrigation systems.

4.3.4 On-field Irrigation System

The irrigation systems will consist of drip Irrigation system.

4.3.5 Use of Pesticides and Herbicides

The project will be completely GAP (Good Agriculture Practice) compliant so all handling of fertilizers and chemicals will be done in accordance with EURO GAP. The objective of these GAP codes, standards and regulations include, to a varying degree:

- Ensuring safety and quality of produce in the food chain;
- capturing new market advantages by modifying supply chain governance;
- improving natural resources use, workers health and working conditions, and/or
- creating new market opportunities for farmers and exporters in developing countries.

Good Agricultural Practices are "practices that address environmental, economic and social sustainability for on-farm processes, and result in safe and quality food and non-food agricultural products" (FAO COAG 2003 GAP paper).

International standards of best practice in the use of pesticides, fungicides and herbicides in agriculture will be followed. This will include:

- Select chemicals with low toxicity outside target groups (i.e. highly specific), short half-lives and high levels of adsorption (this will prevent leaching);
- Use optimal, not maximal doses;
- Apply for as short periods as possible and select days that are not windy;
- Ensure that there is no overspray that drifts into the adjacent indigenous habitats or into areas of human habitation;
- Given that most of the chemicals will be applied through the irrigation system, using an optimal water management approach based on measured soil moisture levels will also mean that leaching and runoff will be limited.

The ecotoxicity of each chemical will be confirmed using an independent database such as the Pesticide Action Network (PAN) Pesticide Database.

The majority of fertilizer will be applied through the irrigation system, herbicides and fungicides will be applied with boom sprayers or during planting.

4.3.6 Storage of Equipment and Tools

Equipment and tools used on a daily basis will be stored in a temporary storage facility on site. No permanent structures will be on site.

4.3.7 Storage of Food Products

With reference to section 3.2.1, the food products from the irrigation project will be stored in the fresh produce facility that will be constructed on a separate piece of land. However, the fresh produce facility does not form part of this EIA process.

4.3.8 Power Supply

With reference to section 3.2.4, power will be supplied using underground electricity cables to the site from the existing Golf Course Substation located near the site.

4.3.9 Waste Management

Relatively small quantities of waste will be generated during the construction and operation phases. All hazardous waste, i.e. pesticide containers, chemical containers, hydrocarbon contaminated materials, used hydrocarbons etc., will be removed from site and disposed of at the nearest approved waste disposal site in Oranjemund.

4.3.10 Sanitation

Portable toilets with associated septic tanks will be used. The septic tanks will be emptied on a regular basis ensuring no spillages.

4.3.11 Access Roads

The proposed project is located along paths of existing tarred and gravel roads. No new roads will be constructed.

4.3.12 Employment and Housing

About 30 permanent jobs will be created for the operational phase.

The workforce will commute to the designated sites each day during the operation phase and will be accommodated in Oranjemund. No accommodation or any permanent structures will be constructed on site.

5 PROJECT ALTERNATIVES

This section discusses and identies alternatives to the proposed developments, to have the best working models that may have none or those that have the least minimal effects.

5.1 Alternative site locations

The 64 ha site for the proposed development of the project falls under agriculture designated land, with no existing infrastructure except for the Rosh Pinah-Oranjemund road to the north and the Oranjemund airport road to the west of the project site. The Oranjemund Town Council has identified the proposed site, which is situated along the Orange River, based on the soil suitability for agricultural crop production, in order to maximize and ensure agriculture productivity and food security in line with Vision 2030 strategy. Therefore, the project location is considered optimal in terms of water availability, land availability, land ownership and proximity to an urban centre for labour supply. No alternative site has therefore been identified.

5.2 Alternative pump station location

Two possible locations for the pump station have been identified and water samples were taken at each of these locations. However, the chosen option still needs to be confirmed. The decision on the best pumping position in the river is dependent on the water quality results and the most feasible underground pipeline route to the irrigation project.

5.3 Alternative power supply

The construction of an electrical distribution system will involve clearing routes for underground power lines to connect to the existing power supply grid. Furthermore, the potential for a solar PV system, using the sun as an infinite renewable energy resource, is another option that could be investigated and taken into consideration to supply electricity to the proposed irrigation project. A PV power plant is however costly and will require an additional assessment.

Another alternative will be using mobile generators on site. However, if the mobile generators are not properly managed and maintained, this option could lead to oil, diesel and grease spillages that could contaminate the soil.

5.4 Alternative water supply

The irrigation project aims to abstract water from the Orange River of approximately 1 million m^3/annum.

An alternative is to pump and abstract underground water using boreholes. However, due to the presence of the adjacent Orange River, this alternative has not been investigated.

5.5 Alternative crop options

According to Galore, the majority of the land has a high irrigation potential. Various crops are being considered in the Feasibility Study in order to determine their potential and suitability for cultivation in the area as a possible source of revenue.

5.6 Alternative Irrigation Methods

5.6.1 Drip Irrigation

The drip irrigation method is the preferred irrigation method for this project and uses specially designed piping system. It has very high water use efficiency and prevents mineral leaching and soil erosion, even though the capital investment is very high, particularly if the distance to be covered is long and the area to be irrigated large.

5.6.2 Surface Irrigation

In this method, water flows to the land by gravity and may be directly flow to storage reservoir. Though convenient, the method is expensive if the cost of the reservoir is included. Besides, the method requires more water and water use efficiency is very low because a lot more water is lost through evaporation.

5.6.3 Flood Irrigation

This is another form of gravity irrigation but does not need an intake structure to divert the water. It requires the development of channels to maintain water in the fields and, as the flood waters recede the residual moisture is used by the crop. Once the floods and residual moisture have been exhausted the farmer can make use of the shallow water table and construct shallow wells to lift the water by bucket for irrigating the crops.

5.6.4 Sprinkler Irrigation

This method requires head-works and piping systems. Crops are irrigated using the sprinkler equipment/machine that is run by the water force through a pipe. The method has several limiting factors such as: (i) high amounts of water; and (ii) high capital investment. However, the method has very high water use efficiency.

5.7 The "no project" option

Classified as an upper-middle-income country, between 2000 and 2015 Namibia has seen sustained economic growth. However, several hurdles still remain on the road to achieving Zero Hunger – including poverty, malnutrition and deep inequality.

Namibia produces about 40 percent of the food it consumes and is highly dependent on imports. This means that while food is available, price fluctuations can make it difficult to access for 26 percent of Namibian families. This particularly affects the 80 percent of the population who depend on markets to fulfil their food needs. Smallholder farmers also have limited access to nutritious food due to recurrent droughts and floods, low productivity and access to land issues. (Source: www.wfp.org).

The main direct benefit of the project is the local generation of food, thereby increasing Namibian food security and self-reliance. Not implementing the project would result in the region and Namibia in general not benefiting from the increase in food security associated with the project.

Should the project not be implemented then the potential negative impacts addressed in Section 8 of this report would not take place.

6 DESCRIPTION OF THE CURRENT ENVIRONMENT

This section discusses and describes the receiving and baseline environment from a local, regional and national context to determine potential positive and negative environmental issues/impacts that will require further assessment in detail.

This section was compiled utilising the following sources of information:

- Available Specialist Report:
  - Desktop Water Resources Impact Assessment Report for the Proposed Horticulture Irrigation Project on Agricultural Plot 52 & 12 near Oranjemund in the //Karas Region (F, Shagama, 2016) (Appendix G)
- Visual observations during a site visit by I.N.K
- Google Earth
- Atlas of Namibia
- Internet sources

6.1 Climate

Oranjemund is considered to have a desert climate. Like many of the coastal towns in the country, Oranjemund's temperatures do not fluctuate but rather remain relatively average throughout the year. The mean temperature in Alexander Bay is 17.3ºC, ranging from 9ºC in July to 24ºC in January (monthly means). Fog occurs, on average, on more than 100 days per year at Oranjemund. It forms a moist cold air from the ocean and meets the hot dry air of the desert. The climate of Oranjemund is strongly influenced by the cold Benguela current which runs in a northerly direction along the coast, which in turn is driven by the South Atlantic anticyclonic climate system. Although the area is a desert, cool and foggy conditions occur most mornings and strong southerly winds are common in the afternoons (Africa Planning Forum, 2019).

6.1.1 Evaporation

The potential evaporation is more than 2 800 mm/year in Vioolsdrift and downstream on the Orange River, with values higher than 2 600 mm/year in Alexander Bay. On the Fish River, potential evaporation is higher than 2 950 mm/year. Consequently, in average terms, the contribution of rainfall to the runoff of the Orange River downstream of Vioolsdrift and of the Fish River downstream of Ai-Ais is negligible (Fritsch and Troy, 2006).

6.1.2 Rainfall

The average rainfall of Oranjemund recorded for a period of ten (10) years, i.e. 2009 to 2019 is shown in the map below (Figure 3).

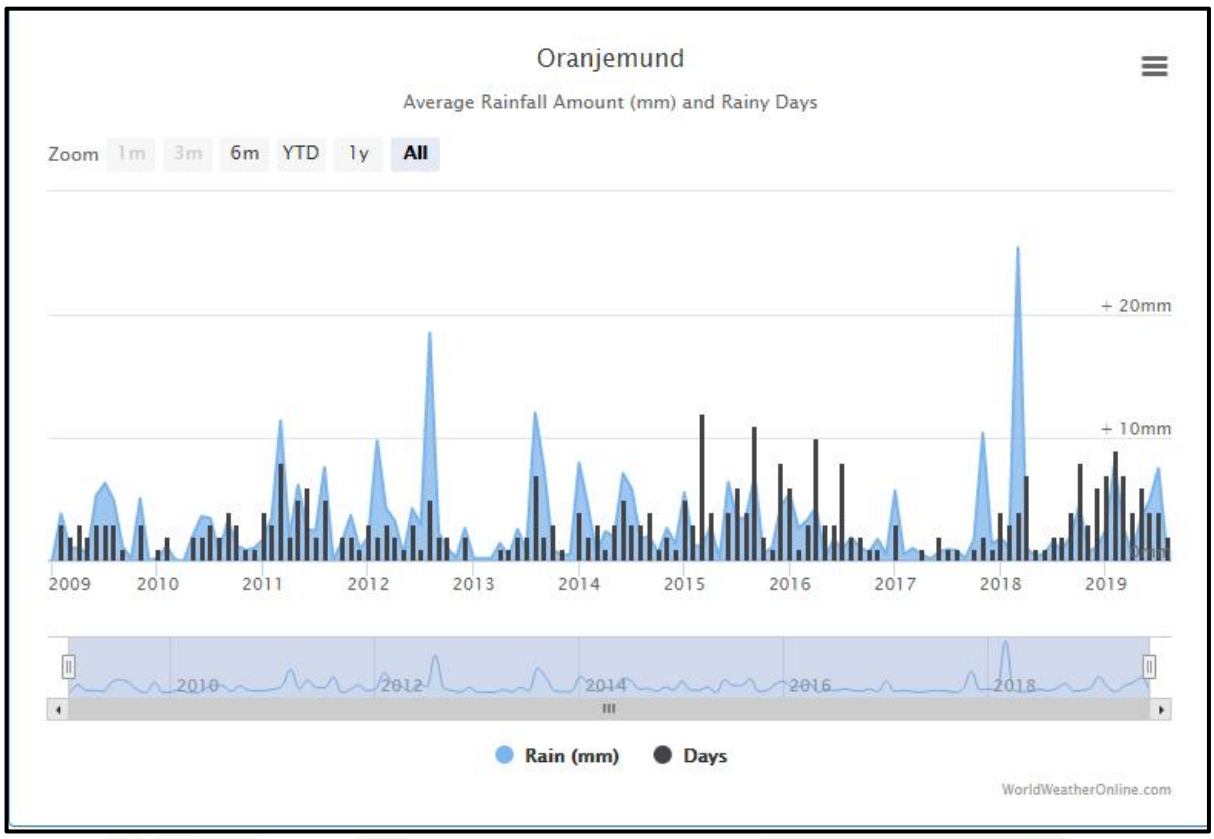

Figure 3: The rainfall patterns in the Oranjemund area (World Weather Online, 2019)

The precipitation is low in the lower part of the Orange River Basin. The mean annual precipitation (MAP) on the lower parts of the Orange River and the Fish rivers are below 100 mm. The MAP on the Orange River is shown in Figure 4 below.

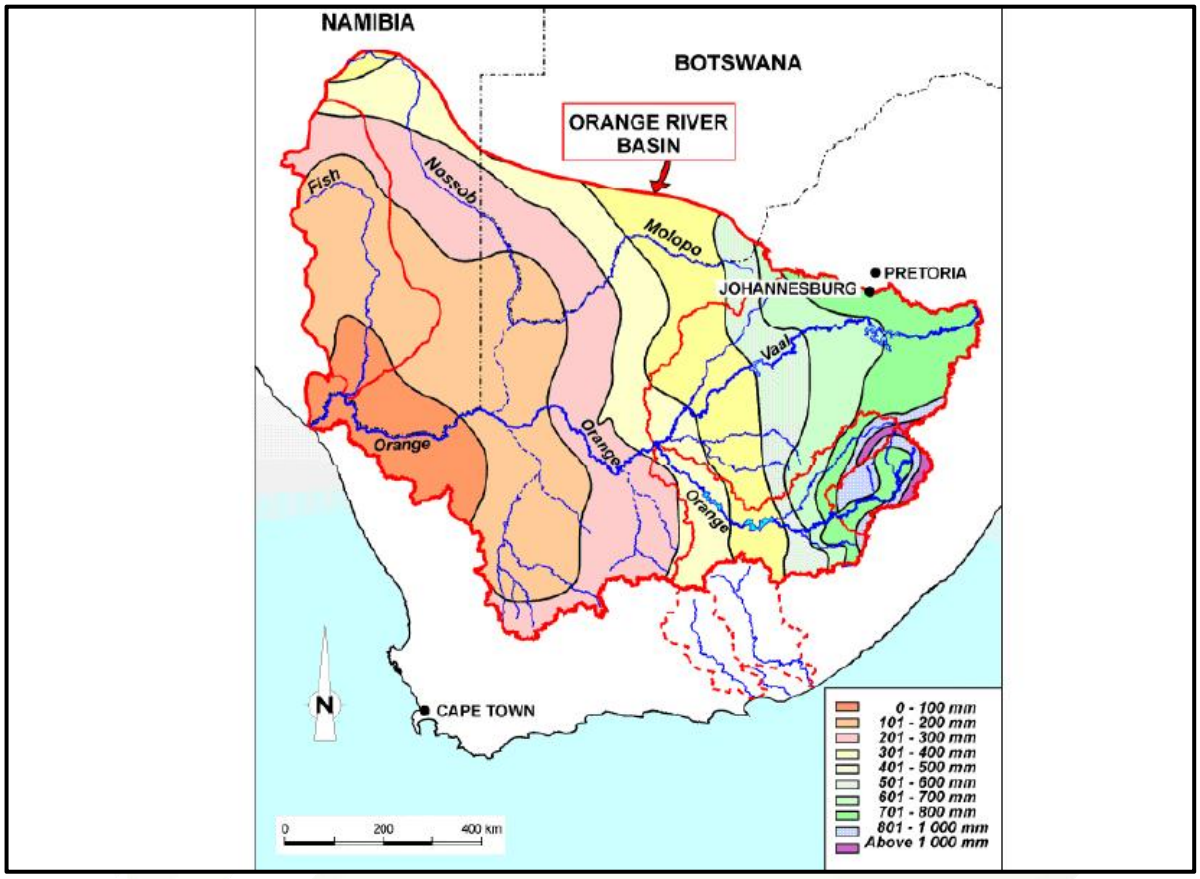

Figure 4: Mean annual precipitation on the Orange River Basin (edited after Fritsch and Troy, 2006)

6.2 Soils

The project site area is covered by the sandy soils of the Namib Desert. In the far west, the Namib is in a hyperarid climate, which severely limits productivity. Areas in the northeastern parts of the //Karas Region receive more rainfall but it drains through the soil rapidly, leaving little moisture for plants. Few nutrients are retained in the porous sand. These characteristics give the Kalahari sandy soils also low carrying capacities. The soils have a negligible amount of organic matter, but will store seeds until conditions become suitable for germination. The distribution of the soils is linked to the topography and wind direction in and around the study area with a common transition point along the major natural watercourse that runs from the north-west to south-east (GCS Water & Environmental Consultants, 2017).

6.3 Geology

The project (study) area is overlain by Namib sediments and overlain by carbonate rocks of the Kalahari Group. These Kalahari Group comprises of unconsolidated to semi-consolidated sand and gravel, locally calcrete and deeper bedrocks of marble, sandstone and quartzite.

6.4 Topography

According to Africa Planning Forum (2019), the Oranjemund area can be described as relatively flat with sparse vegetation. The town is located merely 20 meters above sea level on a virtually flat piece of terrain rock type found in the area is the Kalahari and Namib Sands which is largely dominated by sands.

6.5 Land Use

The Horticulture Irrigation Project is proposed on agriculture designated land that is administered by the Oranjemund Town Council. The area is currently vacant and there are no formal economic activities or residents.

6.6 Hydrogeology

The project area falls under the Southern Namib and Naukluft groundwater basin and according to Koch *et al* (2011), groundwater potential over most of the //Karas Region is classified as low, with only about 30% having moderate potential. Limited water availability in the Namib Desert presents the single largest constraint on development. Mean rainfall is less than 100 mm per year, meaning that sufficient rain to recharge the aquifers only falls in some years.

There are two types of aquifers in the groundwater basin, namely the shallow alluvial primary aquifers along the Orange River, and a variety of deeper hard rock secondary (heavily karstified) aquifers. Alluvial aquifers are generally only recharged by surface water (the Orange River), and are usually considered part of that water resource. Christelis and Struckmeier (2001) added that the occurrence of exploitable groundwater resources in the Namib Desert is closely linked to the existence of alluvial aquifers created by perennial, ephemeral or even fossil rivers. The only abundant source of groundwater in the Sperrgebiet is the alluvial aquifer along the Orange River, which provides a secure supply to Oranjemund.

With that said, the Orange River is the permanent source of water in the Region to towns (such as Rosh Pinah and Oranjemund), mines as well agricultural and tourism projects.

6.6.1 Water Use in the Orange River Alluvial Aquifers: Oranjemund Area

The town of Oranjemund is supplied with water from the Fehlman well. The Fehlman well is a concrete lined shaft with a diameter of 2.9 m and is 17.05 m deep. The well is fed by ten laterals (40 m long) pipes which are radiating horizontally from the bottom of Fehlman well. Water fills these laterals directly from the aquifer (alluvial aquifers fed by the Orange River). The Fehlman well is the biggest supply of freshwater to the town of Oranjemund, producing approximately 800 m3 (800 000 litres) of water per hour. The condition of the well laterals and the level of the aquifer, which is recharged by the Orange River, influence the water table in the well (GCS Water & Environmental Consultants, 2016).

There are eight production wells in this area that are responsible for the augmentation of bulk water, located on the north bank of the Orange River. These wells under optimum conditions produce 640 m3 (640 000 litres) of water per hour.

6.6.2 Water Quality: Orange River Alluvial Aquifers

In 2016 GCS Water & Environmental Consultants analysed the available water data. The available borehole information at the time obtained from Namdeb's old groundwater database showed that, twelve (12) boreholes had been profiled for Electrical Conductivity (EC) between January 1999 and December 2003. Conductivity readings have also been taken from the taps at the (water) production boreholes. Conductivity readings are taken to give early warning of possible deterioration in the quality of the water supplied. The EC values of the monitoring boreholes water increased with depth, ranging from 0.10 to 0.60 mS/m.

There was found to be a big gap in water monitoring data over the years whereby either there is no data for a specific year or there is very little data for certain years. Based on the available monitoring boreholes' data analyzed, the water quality of the alluvial aquifer is classified Group A, which is water of excellent quality and good for human consumption.

6.7 Hydrology

All rivers are ephemeral, except for the Orange River with its extensive catchment in wetter South Africa and Lesotho. Total abstraction from the Orange River, for irrigation schemes, mines and towns, already produces a significant deficit in the mean annual runoff at the mouth, which classifies it as a Category D status (largely modified wetland with extensive losses of natural habitat and basic ecosystem functions. Ephemeral rivers in the Region include; Olifants, Nossob, Fish River, Zebra and Tsondab (GCS Water & Environmental Consultants, 2017).

The entire Orange Basin and relevant neighboring catchments have been divided up into 16 hydrological zones.

6.7.1 Orange River Water Use

The prediction of water requirements for purposes planning is based on the primary drivers of water demand, which are population growth and local economic growth. These two factors are intertwined to some extent, as economic growth may stimulate population growth as a result of migration from the rural areas or other urban area with a poor economy (Mahasa *et al,* 2015).

According to Mahasa *et al* (2015), South Africa uses 97% total water withdrawal from the Orange River thus making it the largest water user. It is further mentioned that although Lesotho contributes to over 40% of the stream flow, it only uses 1% of the water resources, further downriver outside the study area Botswana accounts for less than 1%, and Namibia uses about 2%. Agriculture is the main activity in the basin and this account for 61% of water demand in the area such that agriculture-inclined employment accounts for more than 50% of the basin's population.

The water resources of the Orange-Senqu River basin are primarily used for irrigation. Environmental flow requirements are also pretty high, while mining, industries, power generation and domestic consumption consume much less water. Water use differs from region to region; agriculture is the major user of water in the mid- to lower reaches of the Senqu/Orange River, while industrial, mining and domestic uses predominate in the upper reaches of the Vaal River (Orange-Senqu River Awareness Kit, undated). Figure 5 below shows the water use by country and industry.

	Lesotho	South Africa (Upper & Lower Orange River)	Botswana (groundwater only)	Namibia (Surface Orange River only)
Agriculture, forestry and fishing	19,27	1 828	0,51	42,78
Mining and quarrying	1	9	—	1,43
Manufacturing and Services	21	54	0,11	—
Households	24	106	0,51	—
Subtotal, all economic uses	43,27	5 199	1,12	44,22
Ecological requirements	No value given	1 743	No value given	No value given

Figure 5: Water use by country and industry, 2000 (Mm3)

As seen in the Figure above, South Africa is the largest user of water from the Orange-Senqu River basin; it uses 97% of total annual use, including environmental flows and inter-basin transfers. Lesotho uses 1%, Namibia 2% and Botswana uses <1% of the total flow in the Orange-Senqu River basin.

6.7.2 Water Use Allocation for Namibia

In Namibia, applications for Water Abstraction Permits are made to the Ministry of Agriculture, Water and Forestry (MAWF). Currently water allocations exist for urban, mining and irrigation purposes. For urban and mining applications, the volumes are based on the predicted water demands of each development and the permits are issued accordingly. The permit allocations for irrigation are based on the area to be irrigated. Namibia has an agreement with South Africa to abstract at least 70 Mm^3/year according to Aquastat Namibia 2009 from the Orange River (Orange-Senqu River Awareness Kit, Undated).

6.7.3 Orange River Water Quality

The quality and quantity of water from rivers is highly variable, this is because of seasonal droughts or floods. The quality of ground water also varies greatly (South African Department of Water Affairs and Forestry, 1996).

In order to establish a baseline water quality, two water samples were taken from the Orange River close to the project site in July 2019 (and analysed in August 2019 by Analytical Laboratory Services). Upon consultation with the officials at the Water Environment Department at MAWF on available Standards on Irrigation Water, the Consultant was informed that Namibia does not have such Standards of its own, therefore the South African Guidelines (Agricultural Use: Irrigation) are used to compare and check compliance of irrigation water in Namibia.

An addition of two independent different water samples were also collected and analysed for human consumption (analysed in June 2019 NamWater Laboratory Services). These samples were compared against the Namibian Drinking Water Quality Standards).

6.7.4 Water Sample Quality Compliance to Standards and Guidelines

The Orange River water samples analyzed were compared to the South African Guidelines (Agricultural Use: Irrigation) to check compliance of irrigation water in Namibia. The samples were found to be compliant. The independent water samples were also found to be compliant with the Standards they were compared to.

The water quality can only remain acceptable and good for as long as the recommended environmental (water) mitigation (management) measures are effectively implemented and monitored. Therefore, Galore Trading should implement the provided measures in order to protect water quality.

6.7.5 Vulnerability of Water Resources to Over-abstraction

The vulnerability of the River water to over-abstraction may be difficult to predict for a Transboundary resource such as Orange River being shared between four countries. However, should the four countries not adhere to their annual water abstraction allocations (as in their water use agreements), given the already felt impact of climate change worldwide, the Orange River may be vulnerable to very low water levels as a result of over-abstraction. This impact would not only be felt by people, but by the biodiversity relying on the same water source.

6.7.6 Vulnerability of Water Resources to Pollution

In areas where extensive agricultural activities are practised, the aspects of water pollution and water protection have increasingly become an issue in most parts of the world.

The surface water bodies / resources are vulnerable to pollution via surface run-offs from irrigated project sites where environmentally unfriendly fertilisers and hydrocarbons or wastewater is handled. Possible pollution may not only originate from the agricultural sites, but the nearby towns and other land uses within proximity of the surface water bodies, such as the Orange River.

In a hyper arid environment like Oranjemund, the impact of surface run-offs from rainfall is less likely as the amount of the magnitude of rainfall is low (not enough to cause flooding from site). Surface run-offs from the project site to the Orange River may only occur through excessive use of water for irrigation. This means water applied to the irrigated site areas may carry fertilisers and waste on the site soils and wash them downstream (to the River), depending on the amount fertilisers and waste found on the ground surface. This likelihood is low and therefore the vulnerability of the water resources to pollution is low to slightly moderate. The vulnerability risk to pollution was assessed based on the climate (rainfall), site soil type, distance from site to the River and probability/likelihood.

6.8 Biodiversity

6.8.1 Flora

Oranjemund forms part of the Succulent Karol Biome and the Succulent Steppe vegetation type. Succulent shrubs are the dominant structure found within this vegetation type. The project area consists of mainly scattered dwarf shrubland. No large trees can be found in vicinity of the the project area.

Figure 6: Dwarf Shrubland

6.8.2 Fauna

In Oranjemund the population of wildlife such as the Oryx, baboons, vervet monkeys and jackals occasionally occur in the area surrounding Oranjemund. Due to the vegetation type which is not too ideal for grazing, livestock farming is not possible. The area also has high numbers of endemic plants, reptiles and frogs.

6.8.3 Birds

The Orange River Mouth is regarded as the sixth most important coastal wetland in southern Africa in terms of the number of waterfowl it supports. The river mouth, mudflats, intrafluvial marshlands, islets near the mouth and adjacent pans provide a sizeable area of sheltered shallow water suitable for concentrations of wetland birds, which use these habitats for breeding purposes or as a stopover on migration routes. The bird population can be as high as 20 000 to 26 000 individuals. Of the 57 wetland species recorded, 14 are listed as either rare or endangered in one or both of the South African and Namibian Red Data Books.

Key waterbird habitats include the western portion of thee saltmarsh (for waders) and the mouth area (for terns and cormorants). The surrounding semi-desert environments are important for Egyptian Geese, Karol

Eremomela, Grey-backed Cisticola, Barlow's Lark and many others. Raptors, such as African Fish Eagle, Osprey, Peregrine Falcon and Black-breasted Snakke-Eagle are regularly observed.

6.9 Noise

Existing noise sources within and around the project site include:

- natural sounds from wind, animals, and birds;
- vehicle movement on the Rosh Pinah – Oranjemund Road and Oranjemund Airport road.

The immediate surroundings of the project site have no communities inhabited in the area. The sensitivity of noise receptors usually increases at night when conditions are quiet, and ambient noise levels are at their lowest. No operational activities are anticipated at night time.

6.10 Heritage Resources

The proposed irrigation project area was surveyed on foot during the site visit conducted by I.N.K.

A detailed search of the entire project site revealed absolutely no archaeological or more recent historical remains or sites.

6.11 Visual

The proposed irrigation project area is located adjacent to the Rosh Pinah – Oranjemund Road to the north and Oranjemund Airport road to west. The site is a greenfield area with dwarf shrublands scattered all over the site. There are no infrastructures/buildings visible in the vicinity of the area.

6.12 Socio-Economic Structure/Profile

Oranjemund is a small mining town with estimated population of around 11000. Thus, the Census 2011 data slightly differ, it counted 3908 people. The demographical profile is still in favour of larger male population, small share of children and young people, very insignificant share of pensioners among others that is typical feature of mining towns.

Until 2011, Oranjemund was a single company owned with the overall responsibilities for the town's socio-demographic structures and economic base. Today Oranjemund is officially proclaimed as a town, subject to several restrictions remaining in place as regards visitor access to the Sperrgebiet and restricted mining areas, which still falls under strict mining rights. The proclamation of the southern mining town as a local authority was published in the Government Gazette of August 1, 2011. Until then Namdeb, the mine operator, was running the town's administration until the ownership transfer was completed. Thus, the proclamation guaranteed the general public with the opportunity to participate in the development of the town and its hinterland. In 2018 Oranjemund Town Council and Namdeb Diamond Corporation signed a Memorandum of Agreement on transferring of all municipal services, infrastructures, assets, sales of land and existing improvements.

The town of Oranjemund offers social services and facilities at a level usually only found in much bigger towns. These include health facilities, schools, a technical college, a crèche, a public library, parks, recreation facilities and sports fields. Although Oranjemund remains a relatively newly proclaimed town, it

nevertheless has developed a viable commercial service and industrial sector. There are more than 30 social and recreation clubs in Oranjemund, including horse riding, yachting, golf, soccer, tennis, youth clubs and gymnasiums. The town boasts one of the few golf courses on the west coast which always shows up clearly as a patch of green vegetation in an otherwise desolate and vegetation free area.

Oranjemund has always rated itself as a highly safe and secure town for its residents with an exceptionally low crime rate. This is partly due to the isolated nature of the town and its small size, but mostly because of the security measures which are implemented around the diamond industry. However, local residents and business operators report a recent increase in the crime rate which they attribute to the opening up of the town the public (RBS, 2019).

The upgrade of Oranjemund airport is welcome development as it will not only halt the projected decline in operating Oranjemund airport and make the airport safe for its users, but also to uplift local economy and image of town. However, one must be cautious with over investment and enlargement of infrastructure that belongs to a private owner. If the infrastructure does not match the population that will remain after closure of diamond exploration and recovery activities, the town will find it difficult to sustain and maintain such infrastructure. Current project does not indicate such potential threats and it may have more positive impacts than negative.

7 IDENTIFICATION OF ENVIRONMENTAL ASPECTS AND POTENTIAL IMPACTS

This section discusses the environmental aspects of project activities and the resultant potential environmental impacts.

The consultation process with key stakeholders that included government authorities and I&APs allowed the opportunity to raise the issues associated with the project development. It was identified that; the following aspects will need to be further assessed:

- Groundwater and Surface Water;
- Noise Pollution
- Visual Impact
- Waste Management
- Socio-economic
- Biodiversity

The relevance of the potential impacts ("screening") are also presented in the tables below to determine aspects to be assessed in further detail (Section 8 of this report).

7.1 Information collation

I.N.K used various sources to identify both the environmental issues associated with the proposed project and the Terms of Reference for the required investigations.

Information for the preparation of the EIA Report was sourced from:

- Project information provided by Galore Trading cc which includes:
  - Site layouts; and
  - Technical and process information.
- Site visit by the I.N.K Project Team;
- Specialist Assessment including as identified above;
  - Groundwater and Surface Water;
- Consultation with the Technical Project Team;
- Consultation with IAPs as indicated above;
- Consultation with relevant authorities; and
- Atlas of Namibia.

In case of people related impacts, the assessment focused on third parties and did not assess health and safety impacts on workers because the assumption was made that these aspects are separately regulated by health and safety legislation, policies and standards.

Table 6: Environmental aspects and potential impacts associated with the oranjemund irrigation project

ACTIVITY / FACILITY	ASPECT	POTENTIAL ENVIRONMENTAL IMPACT	RELEVANCE (SCREENING) OF POTENTIAL IMPACT	Ref
Construction of logistics centre (processing, office and workshop.	Clearing of vegetation and soil stripping (earthmoving equipment)	Potential impact on biodiversity (physical impacts and general disturbance) • Loss of habitat • Loss of biodiversity	With reference to section 5.8.1, fauna and flora were identified in the study area. The potential impacts on biodiversity have been assessed as part of this EIA. Refer to Section 8 for the assessment of the potential impacts relating to biodiversity.	**R01**
		Potential impact on archaeological sites • Destruction and loss of archaeological sites	With reference to section 5.10, a detailed search of the entire project site revealed absolutely no archaeological or more recent historical remains or sites. Refer to Section 8 for the assessment of the potential impacts on Heritage resources. Related management and mitigation measures (relating to archaeological chance finds) are however stipulated in the updated EMP (refer to Appendix K).	**R02**

ACTIVITY / FACILITY	ASPECT	POTENTIAL ENVIRONMENTAL IMPACT	RELEVANCE (SCREENING) OF POTENTIAL IMPACT	Ref
	Oil and diesel spillages from vehicles and other equipment	Impact on surface water and groundwater water quality.	The proposed irrigation project may pose the risk of contamination of water resources, mainly through accidental spills of oil and diesel etc. Due to the nature of the project, there is a low risk of big hydrocarbon spillages. However, due to the water from the area being critical, the potential impacts on surface water and groundwater have been assessed as part of this EIA. Refer to Section 8 for the assessment of the potential impacts relating to surface water and groundwater.	**R03**
	Dust and gaseous emissions from vehicles	Impact on 3rd party health and safety	The immediate surroundings of the project site have no communities inhabited in the area, therefore impact of air pollution on communities is minimal. The only potential receptors of dust and gaseous emissions (during operations phase) are travelers on the Rosh-Pinah and Oranjemund Airport road.	
	Water abstraction from the river	Cumulative effects as a result of water abstraction from the Orange River	The cumulative effects arising from the abstraction of water from the Orange River is not assessed and part of this study. However, should the four countries not adhere to their annual water abstraction allocations (as in their water use agreements), given the already felt impact of climate change worldwide, the Orange River may be vulnerable to very low water levels as a result of over-	

ACTIVITY / FACILITY	ASPECT	POTENTIAL ENVIRONMENTAL IMPACT	RELEVANCE (SCREENING) OF POTENTIAL IMPACT	Ref
			abstraction.	
General operational activities, offices and buildings, domestic waste generation	Transportation of agricultural products	Injury to people and animals and 3rd party health and safety impacts	With reference to section 3.2.6, the horticulture irrigation project is located ±2 km southeast of Oranjemund, taking either the Rosh-Pinah Oranjemund road or the Oranjemund airport road, ±1.5 km southeast of Oranjemund. The transportation route will follow the same scenario. Thus, the increased traffic on the roads and the intersection to the access road can cause accidents that may lead to death and/or injury to people and animals.	**R04**
	Noise from the booster pumps	Increase in disturbing noise levels (nuisance impact to third parties)	With reference to section 5.5, the Horticulture Irrigation Project is proposed on agriculture designated land that is administered by the Oranjemund Town Council. The area is currently vacant and there are no formal economic activities or residents. The sensitivity of noise receptors usually increases at night when conditions are still, and ambient noise levels are at their lowest. However, no operational activities are anticipated at night time. A Qualitative noise assessment was therefore conducted by I.N.K in section 7 of this report	**R05**

ACTIVITY / FACILITY	ASPECT	POTENTIAL ENVIRONMENTAL IMPACT	RELEVANCE (SCREENING) OF POTENTIAL IMPACT	Ref
	Waste disposal	Emissions to land, impact on biodiversity, environmental degradation and nuisance impacts	Existing waste management practices will be improved, and Galore Trading cc will further develop waste management procedures. Waste will be separated at source and stored in a manner that there can be no discharge of contamination to the environment. Some waste types will be recycled or reused where possible. Where recycling/re-using is not possible non-hazardous, non-recyclable waste will be disposed of at the Oranjemund waste landfill site. The related management and mitigation measures are stipulated in the EMP (refer to Appendix K) and no further assessment is required.	
	Sewerage management			**R06**
	Visual Impacts	Changes in visual conditions	The proposed project will take place in a currently undisturbed area and will therefore create a negative visual impact. The project will also be located alongside the Rosh-Pinah Oranjemund road and the Oranjemund airport, which will create a visual impact for travellers.	**R07**

ACTIVITY / FACILITY	ASPECT	POTENTIAL ENVIRONMENTAL IMPACT	RELEVANCE (SCREENING) OF POTENTIAL IMPACT	Ref
			A Qualitative noise assessment was therefore conducted by I.N.K in section 8 of this report.	
General operations, employment and resource management	Economic impacts	Impacts on local economy, informal settlements, • Increased employment opportunities • Opportunity for skills transfers • Improvement in the business environment • Increasing pressure on government services • Increased demand for basic infrastructure • Increased social ills, e.g family breakdowns, teenage pregnancies etc.	With reference to section 3.3.10, the construction phase will employ ±50 people over a period of 4 months and about 30 permanent jobs will be created for the operational phase. However, it is likely that a certain number of the project's workforce during operations will come from outside the immediate community and will thus put increased demand on local services in Oranjemund town. It is likely that many job-seekers will come to the area; many will not be successful but with no other prospects, they may wait in the area in the hope that a job is forthcoming. This could lead to negative social issues. The potential socio-economic impacts (positive and negative) have therefore been assessed as part of this EIA. Refer to Section 7 for the assessment of these potential impacts.	**R08**

8 ENVIRONMENTAL IMPACT ASSESSMENT

This section discusses, provides ratings and gives recommendation on the major positive and negative potential issues/impacts identified.

8.1 Assessment Approach and Methodology

Both the criteria used to assess the impacts and the method of determining the significance of the impacts is outlined in Table 7. This method complies with the EIA Regulations: EMA, 2007 (Government Gazette No. 4878) EIA regulations.

Part A provides the approach for determining impact consequence (combining severity, spatial scale and duration) and impact significance (the overall rating of the impact). Impact consequence and significance are determined from Part B and C. The interpretation of the impact significance is given in Part D.

Both mitigated and unmitigated scenarios are considered for each impact in the EIA results.

Table 7: Assessment Methodology and Criteria

PART A: DEFINITION AND CRITERIA		
Definition of SIGNIFICANCE		**Significance = consequence x probability**
Definition of CONSEQUENCE		**Consequence is a function of severity, spatial extent and duration**
Criteria for ranking of the SEVERITY/NATURE of environmental impacts	**H**	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action. Irreplaceable loss of resources.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints. Noticeable loss of resources.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints. Limited loss of resources.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	**L**	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE of impacts	**L**	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Within 20 km of the site boundary.
	H	Widespread – Far beyond site boundary. Regional/ national

PART B: DETERMINING CONSEQUENCE					
SEVERITY = L					
DURATION	Long term	**H**	**Medium**	**Medium**	**Medium**
	Medium term	**M**	**Low**	**Low**	**Medium**
	Short term	**L**	**Low**	**Low**	**Medium**
SEVERITY = M					
DURATION	Long term	**H**	**Medium**	**High**	**High**
	Medium term	**M**	**Medium**	**Medium**	**High**
	Short term	**L**	**Low**	**Medium**	**Medium**
SEVERITY = H					
DURATION	Long term	**H**	**High**	**High**	**High**
	Medium term	**M**	**Medium**	**Medium**	**High**
	Short term	**L**	**Medium**	**Medium**	**High**
			L	**M**	**H**
			Localised Within site boundary Site	Fairly widespread Beyond site boundary Local	Widespread Far beyond site boundary Regional/ national
			SPATIAL SCALE		

PART C: DETERMINING SIGNIFICANCE					
PROBABILITY (of exposure to impacts)	Definite/ Continuous	**H**	**Medium**	**Medium**	**High**
	Possible/ frequent	**M**	**Medium**	**Medium**	**High**
	Unlikely/ seldom	**L**	**Low**	**Low**	**Medium**
			L	**M**	**H**
			CONSEQUENCE		

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	**Decision guideline**

High	It would influence the decision regardless of any possible mitigation.
Medium	It should have an influence on the decision unless it is mitigated.
Low	It will not have an influence on the decision.

8.2 Issue/Impact: Noise pollution impact on the biophysical and social environment

Introduction

The noise that will be emitted during the construction phase could impact the wild animals roaming around the site.

Assessment of impact

Severity

The presence of animals within close proximity of the project results in a high severity with regard to noise pollution impacts in the unmitigated scenario. The severity of this impact would be high in the unmitigated scenario and could be reduced to medium through mitigation.

Duration

The noise impact is reversible overtime therefore the duration in the unmitigated and mitigated scenarios are medium.

Spatial Scale

The noise pollution impacts would extend beyond the site boundaries. The spatial scale is therefore medium in both the unmitigated and mitigated scenarios.

Consequence

the consequence of this impact is medium in the unmitigated scenario and low in the mitigated scenario.

Probability

The probability of the noise pollution impact occurring is high in the unmitigated scenario and medium in the mitigated.

Significance

The significance of noise pollution impacts is medium because the consequence and probability of the impacts occurring are medium and high, respectively.

Table 8: Summary of the assessed impact: Noise pollution impact on the biophysical and social environment

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability	Significance
Unmitigated	H	M	M	M	H	M

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability	Significance
Mitigated	M	M	M	L	M	L

Recommendations and mitigation measures

Objective

To minimize the impacts of noise pollution emitted from the site during construction on the wild animals, Galore will:

- Ensure general construction and operational activities follow good engineering practice including:
    - Regular maintenance of all diesel-powered equipment.
    - Enclosure of major sources of noise.
    - Following of good design philosophies for vibrating structures that are known to be noisy.
- Noise-generating activities limited to daytime hours since noise impacts are most significant during the night.
- Acoustic barriers are proven to be effective in reducing environmental noise impacts.
- Minimise individual vehicle engine, transmission and body noise or vibration through the implementation of an equipment maintenance programme and minimise the need for trucks or equipment to reverse.

Emergency situation

Galore will maintain good relations with the Oranjemund Town Council and have clear points of contact to enable a speedy response to an emergency situation.

8.3 Issue: Impact relating to visual

Introduction

The irrigation project will create a negative visual impact to the nearby community. The factory will also be located adjacent to the Rosh Pinah – Oranjemund Road to the north and Oranjemund Airport road to the west, posing a visual impact to the travellers on the road.

Severity

The severity of visual impacts is determined by assessing the change to the visual landscape as a result of the project for receptors in the area. The visual receptors are the immediate travellers on the Rosh

Pinah – Oranjemund road and Oranjemund Airport road. The severity of the impact will therefore be medium in the unmitigated scenario and medium in the mitigated scenario.

Duration

The duration of the visual impact, will be for the life of the project and therefore will be medium in both the unmitigated and mitigated scenarios.

Spatial Scale

The human receptors and change of visible visual landscape will result in a medium spatial scale of visual impact.

Consequence

The consequence of this impact is medium in both the unmitigated and mitigated scenarios.

Probability

The probability of the visual impact occurring is high in both the unmitigated and mitigated scenarios for the reasons described above.

Significance

The significance is medium in both the unmitigated and mitigated scenarios.

Table 9: Summary of Cumulative Physical Impacts on Visual Environment

MITIGATION	SEVERITY	DURATION	SPATIAL SCALE	CONSEQUENCE	PROBABILITY	SIGNIFICANCE
Unmitigated	**M**	**M**	**M**	**M**	**H**	**M**
Mitigated	**M**	**M**	**M**	**M**	**H**	**M**

Recommendations and mitigation measures

The objective of the mitigation measures is to limit visual impacts. Key mitigation measures revolve around ensuring that the operations and facilities are well maintained and kept in good order. Poor maintenance and housekeeping would result in the creation of a negative visual impact.

8.4 Issue/Impact: Waste Management

Introduction

With reference to section 4.3.9, relatively small quantities of general (domestic) and hazardous waste will be generated during the construction and operation phases. The general non-hazardous waste will be transported to the Oranjemund landfill site.

Assessment of impact

Severity

The waste that will be generated results in a medium severity in the unmitigated scenario and low in the mitigated scenario.

Duration

The waste management impact is reversible overtime therefore the duration in the unmitigated and mitigated scenarios are medium.

Spatial Scale

The waste management impacts would be localised within the site boundaries. The spatial scale is therefore both low in the unmitigated and mitigated scenarios.

Consequence

The consequence of this impact is medium in the unmitigated scenario and low in the mitigated scenario.

Probability

The probability of the waste management impact occurring is medium in the unmitigated scenario and low in the mitigated.

Significance

The significance of waste management impacts is medium because the consequence and probability of the impacts occurring are medium.

Table 10: Summary of the assessed impact: Air pollution impact on the biophysical and social environment

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability	Significance
Unmitigated	M	M	L	M	M	M
Mitigated	L	M	L	L	L	L

Recommendations and mitigation measures

Objective

To minimize the impacts of waste management on site during construction and operations:

Galore will:

- Ensure suitable receptacles with lids for waste disposal is available on site at all times.
- Ensure animals and people do not have access to waste bins.
- If rubbish containers are used, ensure these can be sealed from animals or strong wind and during transportation.
- Waste shall be transported to the Oranjemund waste disposal site on a weekly basis.
- No disposal of waste on site and no burning of waste.
- Hazardous Waste (if any) will be disposed of at the nearest hazardous waste disposal facility.
- Written evidence of safe disposal of waste will be kept.

8.5 Issue/Impact: Socio-Economic impacts

Introduction

The project has the potential to create significant socio-economic benefits through employment creation, economic contributions and food security. Namibia's "Green Scheme Policy" (MAWF, 2008) states "*[t]he mandates of the Ministry of Agriculture, Water and Forestry is the promotion, development, management and utilisation of agricultural, water and forestry resources. It is, therefore, the objective of the Government to ensure agriculture productivity and food security in line with Vision 2030 strategy*." As stated in Section 1, the proposed Irrigation Project falls under the ambit of Namibia's "Green Scheme". The benefits include employment opportunities, skills and development training and indirect capital injection into businesses in Oranjemund and overall Erongo Region.

About 30 permanent jobs will be created for the operational phase.

The workforce will commute to the designated sites each day during the operation phase and will be accommodated in Oranjemund. No accommodation or any permanent structures will be constructed on site.

Assessment of impact

Severity

Job creation is a high priority to the Namibian government to combat widespread unemployment and disparities in income. As some of the proposed jobs created can be filled by training unskilled people, the factory will make a small but useful contribution. Employment provides incomes to the employees, their immediate household members and to relatives living elsewhere in Namibia who depend on cash remittances. As long as the jobs created do not cause the loss of jobs in the surrounding area, the impact can be summarised as having a **high positive** effect.

Duration

In the normal course, the direct positive economic impacts associated with the project will occur for the life of operations. After decommissioning and closure there will be limited opportunities through aftercare and monitoring activities. The project would have contributed to the establishment of a critical economic mass and hence the benefits of wealth creation and a better skilled workforce are expected to continue beyond the life of operations.

Quantitatively assessing the post closure impacts is not possible at this stage as there are a number of important unknown factors such as the general state of the future economy (local, national and world-wide) and the future state of the energy and other industrial sectors.

The contribution to skills development will be long-lasting so the duration will be high.

Spatial Scale

In both the unmitigated and mitigated scenarios, the impact will be experienced both in the region and throughout Namibia. The spatial scale is widespread beyond the project site and is therefore classified as high.

The spatial scale is high as employees will be sourced locally and from the neighbouring regions and nationally.

Consequence

The consequence of the impact is high positive.

Probability

The probability is high as jobs will definitely be created for the life of the factory.

Significance

The significance of this potential impact is high positive and can be enhanced further. Our confidence in this rating is high.

Table 11: Summary of the assessed impact: Job creation and skills development

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability	Significance
Unmitigated	H+	H	H	H+	H	H+
Mitigated	H+	H	H	H+	H	VH+

Recommendations and mitigation measures

The enhancement objective is to maximise employment and skills development opportunities for the local, regional and national population.

The project requires low, semi-skilled to highly skilled labour force so there is a great need to provide up-front skills training. Skills acquisition/upgrading provides greater opportunities for the local labour force to participate in the project and makes a crucial contribution towards long-term sustainability, beyond the life of the factory. It can also contribute to improving gender equality and the empowerment of women.

Galore will:

- Have approachable person as she/he will be a key link between the community in the area and the factory.
- Demonstrate its efforts to recruit employees from Oranjemund and Karas Region.
- Be gender sensitive and select women for interview, training and recruitment.

8.6 Issue/Impact: Biodiversity

Introduction

The following list presents activities identified during the project development phases that can be referred to sources of risk to biodiversity. The resultant impacts (Issues) are assessed in the sections below.

- Clearing of land and handling and deposition of material cleared from the site;
- Construction and maintenance of access roads;
- Use of roads by vehicles;
- Introduction of large amounts of pesticides and herbicides into a novel environment;
- Introduction of large amounts of nitrogen-based chemicals into the environment;
- Human behaviour:
    - Collection of firewood,
    - Sanitation practices,
    - Illegal collection of plants and animals.

Overall, impacts may increase or decrease the risk of species persistence through indirect or direct effects on population processes, chiefly as a result of alteration of habitat size, quality and cohesiveness, as well as alteration of key ecological processes.

Assessment of impact

Issue: Direct destruction of organisms and their habitats

Intensity

The death of plants and animals, as well as dormant invertebrates, could be caused by the removal or destruction of individual organisms during construction activities or by being struck by vehicles and machinery. Direct impacts to birds include removal of nest sites in plants and on the ground.

Given the above, the cumulative unmitigated severity is medium, but may be reduced to low with the successful implementation of the mitigation measures.

Duration

The site will be transformed by the proposed activity for the long-term and the impacts on sensitive habitats would be permanent (high duration). However, should certain key habitats be avoided, then the impact duration will be low.

Spatial Scale

Although the direct impacts may occur within the site boundary, the project could contribute to the cumulative loss of sensitive habitats at a broader scale. The spatial scale of the project is therefore medium in both the mitigated and unmitigated scenarios.

Consequence

In the unmitigated scenario, the consequence of the potential impact is medium, and this reduces to low with mitigation.

Probability

Without any mitigation the probability associated with the impacts is medium. With mitigation, the probability of impacts will be reduced to low because probability of impacts on the sensitivities would be reduced.

Significance

The significance of this potential impact is medium in the unmitigated scenario and low for the mitigated scenario.

Table 12: Summary of the assessed impact: Job creation and skills development

Mitigation	Severity	Duration	Extent	Consequence	Probability	Significance
Unmitigated	M	H	M	M	M	M
Mitigated	L	M	L	L	L	L

Recommendations and mitigation measures

Galore will:

- Optimise the total size of the irrigation area by carefully considering the realistic productive capacity of the soils (use only the area that is needed to produce the target production).
- Do not clear one contiguous block of vegetation; rather follow the principle of patch dynamics and clear multiple smaller blocks, each divided from the next by a patch of natural bush.
- Avoid clearing and developing farming units and infrastructure over Shallow Depressions and leave an intact buffer strip of at least 20m
- Raise awareness through awareness campaigns and training of key staff.

Issue: Pollution of environment with pesticides (which comprise insecticides, herbicides and fungicides)

This impact could result from the application of pesticides as a routine measure to decrease herbivory, seed predation and interspecific competition. The runoff of all chemicals into permanent water bodies and leaching into groundwater would have further impacts on the regional biodiversity.

Severity

Pesticides form one of the three pillars of the so-called 'green revolution'; the other two being new and rapidly replaced seed varieties, and high fertilizer inputs. Because invertebrate organisms are a food source for a large number of vertebrates, pesticides, even the ones that are designed to affect only one or two target groups, have spill over effects on the ecosystem and may cause morbidity and mortality in secondary consumers of all kinds (SLR, 2015).

Effects of compounds that are not completely biodegradable are cumulative, building up in groundwater and open water bodies over time and could have significant impacts on the regional ecosystem.

Although direct contact may cause death of organisms, the most critical aspect is perhaps the potential for chemicals to:

- Spread beyond the site boundaries;
- Leach into groundwater;
- Migrate to open water;
- Build up in the environment over time.

Herbicides, especially those that disrupt reproductive processes in plants, may have similar effects on native plants and result in a localised alteration of population sizes.

Given the above, the cumulative unmitigated severity is high, but may be reduced to low with the successful implementation of the mitigation measures.

Duration

The impacts on biodiversity would be medium in both the unmitigated and mitigated scenarios.

Spatial scale

Although the direct impacts may occur within the site boundary, the project could contribute to the cumulative impacts at a broader scale. The spatial scale of the project is therefore medium in the unmitigated scenario but can be reduced to low through mitigation.

Consequence

In the unmitigated scenario, the consequence of the potential impact is medium, and this reduces to low with mitigation.

Probability

Without any mitigation the probability associated with the impacts is high. With mitigation, the probability of impacts will be reduced to low.

Significance

The significance of this potential impact is medium in the unmitigated scenario and low with mitigation.

Table 13: summary of pollution of the environment with pesticides

Mitigation	Severity	Duration	Extent	Consequence	Probability	Significance
Unmitigated	H	M	M	M	M	M
Mitigated	L	M	L	L	L	L

Recommendations and mitigation measures

Galore will:

- Not rely on chemicals as the main form of pesticide control. Rather use it as part of an integrated pest management approach. This will require monitoring of both the presence and abundance of different pests (fungi as well as invertebrates) and the effects of different management options.
- Follow international standards of best practice in the use of pesticides, fungicides and herbicides in agriculture (e.g. http://www.ext.colostate.edu/pubs/crops/xcm177.pdf). This will include:
    - Select chemicals with low toxicity outside target groups (i.e. highly specific), short half-lives and high levels of adsorption (this will prevent leaching);
    - Use optimal, not maximal doses;
    - Apply for as short periods as possible and select days that are not windy;
    - Ensure that there is no overspray that drifts into the adjacent indigenous habitats or into areas of human habitation;
    - Given that most of the chemicals will be applied through the irrigation system, using an optimal water management approach based on measured soil moisture levels will also mean that leaching and runoff will be limited.
- Confirm the ecotoxicity of each chemical using an independent database such as the Pesticide Action Network (PAN) Pesticide Database.
- Herbicides are used widely, but there is little information on their effects on the plants of African savannas. It is best to adopt a precautionary approach here and assume that there will be negative effects on native plant species and that a very strictly controlled and directed application regime should be followed.

- Integrated pest management (IPM) is the control strategy of choice. IPM is an approach to pest management that blends all available management techniques - nonchemical and chemical - into one strategy: Monitor pest problems, use nonchemical pest control, and resort to pesticides only when pest damage exceeds an economic or aesthetic threshold.

Issue: Soil and water pollution by application of fertiliser

The primary source of risk in this regard relates to the application of nitrogen- and phosphorous–based fertilisers to improve growth and overall yield of most crops.

Severity

The main problem with the use of fertilisers in an agricultural project in this particular site is related to the focal increase of nitrogen in an essentially dystrophic environment (acidic water that is low in oxygen and supports little life). Excessive nitrogen, particularly if applied over extended periods, will cause eutrophication resulting in overgrowth of nitrogen-fixing weeds on land and algae in water. Increased foliar application of N-based fertilisers can also increase the risk of crop diseases (McLaughlin & Mineau 1995), necessitating higher use of pesticides (SLR, 2015).

Fertiliser impacts on biodiversity will most likely only occur when application levels exceed levels that the crop plants can use.

Given the above, the cumulative unmitigated severity is medium, but may be reduced to low with the successful implementation of the mitigation measures.

Duration

The impacts on biodiversity would be medium in both the unmitigated and mitigated scenarios.

Spatial scale

This impact may extend beyond the project boundary. The spatial scale is therefore medium in the unmitigated scenario. This can be reduced to low through mitigation.

Consequence

In the unmitigated scenario, the consequence of the potential impact is medium, and this reduces to low with mitigation.

Probability

Fertilisers have to be utilised in this context as there are insufficient soil nutrients to support this level of intensive agriculture. The probability of the impact occurring is therefore medium in both the unmitigated and mitigated scenarios.

Significance

The significance of this potential impact is medium in the unmitigated scenario and mitigated scenarios.

Table 14: summary of Soil and water pollution by application of fertiliser

Mitigation	Severity	Duration	Extent	Consequence	Probability	Significance
Unmitigated	M	M	M	M	M	M
Mitigated	L	M	L	L	M	M

Recommendations and mitigation measures

Galore will:

- Follow international best environmental practice in the application of all fertilisers. This should include:
    - Base dosage rates of N and P on their soil levels – high levels in the soil should be a trigger to scale back on application;
    - Use forms of fertilisers that are readily and quickly taken up by plants.

Issue: Interference with movement of large mammals to and from the river and with smaller mammals moving to and from patches of habitat in the irrigation area

Although signs of large animal presence were found, the installation of a stock-proof fence will definitely cut off the movement of all animals larger than the larger rodents.

Severity

Whether natural patches are left, the irrigation circles will also influence the impact of the fences: many species won't be attracted to cultivated areas anyway, so the effect of loss of habitat becomes a more important impact.

Given the above, the cumulative unmitigated severity is low in both the unmitigated and mitigated scenarios.

Duration

The impacts on biodiversity would be long term (medium) in both the unmitigated and mitigated scenarios.

Spatial scale

This impact will be on fauna outside of the project boundaries. The spatial scale is therefore medium in both the unmitigated and mitigated scenarios.

Consequence

The consequence of the potential impact is low in both the unmitigated and mitigated scenarios.

Probability

The probability of this potential impact occurring is low.

Significance

The significance of this potential impact is low in both the unmitigated and mitigated scenarios.

Table 15: Interference with movement of large mammals

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability	Significance
Unmitigated	L	M	M	L	L	L
Mitigated	L	M	M	L	L	L

Recommendations and mitigation measures

Galore will:

- Monitor the occurrence of tracks of animals around the boundary fence, with particular attention being paid to evidence of the interruption of linear movements.

8.7 Issue/Impact: Groundwater

Issue: Groundwater Quality Impacts

Percolation of irrigation water could deteriorate the groundwater quality, depending on the quality of the water applied for irrigation relative to the current groundwater quality, and whether this is over-applied, resulting in accelerated percolation of irrigation water into the regional aquifer.

Severity

The project will comply with GAP codes and practices (refer to section **Error! Reference source not found.**). Adhering to the GAP codes and standards with regard to the use of pesticides, fungicides and herbicides will include:

- Select chemicals with low toxicity outside target groups (i.e. highly specific), short half-lives and high levels of adsorption (this will reduce leaching problems);
- Use of optimal, not maximal doses;
- Application for as short periods as possible and selecting days that are not windy; and
- Ensuring that there is no overspray that drifts into the adjacent indigenous habitats or into areas of human habitation.

Further, most of the chemicals will be applied through the irrigation system and using an optimal water management approach based on measured soil moisture levels will also mean that leaching will be limited. Overall the severity of the impacts on groundwater quality will be lowered through the implementation of the above-mentioned codes and standards.

The fact that the project will use GAP compliant pesticides, fungicides and herbicides, the severity of the impacts on groundwater will be medium (as opposed to high in the context of uncontrolled use thereof). This can however be reduced to low through further mitigation.

Spatial Scale

The impact would extend beyond the site boundary as contamination transport is expected to follow the groundwater flow patterns, hence medium influence in both the unmitigated and mitigated cases.

Duration

The duration of potential for pollution from irrigation is longer than the operations, so the impact duration is high in both the unmitigated and the mitigated scenarios.

Consequence

Based on the above assessment the determining consequence is medium in the unmitigated case and medium in the mitigated case.

Probability

Probability of occurrence is medium in the unmitigated case and low in the mitigated case.

Significance

The significance of groundwater contamination due pesticides, fungicides and herbicides use is high in the unmitigated scenario but is low in the mitigated scenario.

Table 16: Groundwater quality impacts

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability	Significance
Unmitigated	M	H	M	M	M	H
Mitigated	L	H	M	M	L	L

Recommendations and mitigation measures

Objectives:

- Reduce concentration of contaminants in irrigation water to prevent pollution of underlying aquifer.
- Effectively control the volumes of water used to irrigate crops thereby reducing water logging and subsequent recharge.

Galore will:

- Apply water efficient irrigation methods and control of volumes of water used for irrigation.
- Have proper storage of chemicals and fertilisers on site.
- Comply with EURO GAP standards.
- Plant crops that are adapted to the climate and soil conditions and that don't require excessive volumes of pesticides and fertilizers.

- Maintain equipment to prevent leakages of contaminants.
- Dispose of materials properly at a suitable disposal site.
- Implement a groundwater quality monitoring programme at the irrigation site and in areas where groundwater is used downstream, e.g. in production boreholes of communities near the irrigation project. Issue: Impacts on surface water runoff volumes.

This section addresses the likely effects of the proposed irrigation project development on runoff potential.

Issue: Groundwater quantity

Negative impacts would be caused if the precipitation of excess irrigation water resulted in salt precipitation or if the irrigation water was contaminated. The project will be fully compliant with Good Agriculture Practice (GAP) carried out in accordance with EURO GAP codes and standards which will ensure limited impact on the environment, so the probable impact should be rated as slightly positive.

Severity:

Increase in recharge from irrigation activities. The severity is considered medium+ in the unmitigated case and low+ in the mitigated case.

Duration:

The duration of potential for recharge from irrigation is related to the irrigation activities, so medium impact in both cases.

Spatial scale:

Beyond the site boundary as recharge is expected to follow the groundwater flow patterns, hence medium influence in both the unmitigated and mitigated cases.

Consequence:

Based on the above assessment the determining consequence is medium in the unmitigated case and low in the mitigated case.

Probability:

Probability of occurrence is medium in the unmitigated case and low in the mitigated case.

Significance:

Summarizing the above assessment, the overall significance is rated as medium in the unmitigated case and low in the mitigated case.

Table 17: Groundwater quantity

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability	Significance
Unmitigated	M+	M	M	M	M	M
Mitigated	L+	M	M	L	L	L

Recommendations and mitigation measures

To reduce the recharge due to excessive irrigation activities, which will result in increased groundwater levels and possibility of salt crusts from evaporation of excess water.

Effectively control the volumes of water used to irrigate crops thereby reducing water-logging and subsequent recharge.

Galore will:

- Install drip irrigation for effective utilisation and control of volumes of water used for irrigation.
- Maintain equipment to prevent leakages, meters on irrigation lines to monitor application rates.
- Monitoring boreholes to monitor groundwater levels. Feedback from monitoring to change irrigation water application rates, should groundwater levels change significantly.
- Operate with reference to EURO GAP codes and standards.

8.8 Issue/Impact: Surface Water

Issue: Pollution of surface water runoff

This section addresses the possible impacts of the proposed irrigation project on surface water quality. The main factors which would affect the water quality are the chemicals and pesticides which would be stored and used on the irrigation farm, as well as fuels and oils from agricultural equipment.

The unmitigated impact was assessed as medium significance. Recommended mitigation measures would consist of all contact storm water generated on site being collected by perimeter berms and

channelled into retention ponds for re-use on site, resulting in little chance for polluted surface water to reach the Orange River. Additionally, if the chemicals and pesticides used on site are EURO GAP compliant, (bio-degradable and / or environmentally acceptable), then the risk of surface water pollution would be further reduced. Sampling of water should be undertaken after heavy rainfall to monitor water quality, to assess whether any pollution from the irrigation project is reaching the channels to the river. With these mitigation measures in place the impact significance reduces to low.

Severity

Possible pollution transported downstream from irrigation farm to Orange River. Possible deterioration especially close to site, so severity is medium in the unmitigated case reducing to low in the mitigated case.

Duration

The duration of potential for pollution is for the life of the irrigation farm project, so medium impact in both the unmitigated and the mitigated cases.

Spatial Scale

Beyond the site boundary possibly down to the Orange River, therefore medium influence in the both the unmitigated and the mitigated cases.

Consequence

Based on the above assessment the determining consequence is medium in the unmitigated case and low in the mitigated case.

Probability

Probability of occurrence is medium in the unmitigated case and low in the mitigated case.

Significance

Summarising the above assessment, the overall significance is rated as medium in the unmitigated case and low in the mitigated case

Table 18: impacts on surface water runoff volumes

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability	Significance

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability	Significance
Unmitigated	M	M	M	M	M	M
Mitigated	L	M	M	L	L	L

Recommendation and Mitigation Measures

Objectives:

- Efficient operation of storm water measures to ensure no spillage or leakage takes place.
- Efficient management of farming practices to ensure possible pollution sources stored and used safely. (GAP compliant operations).

Galore will:

- Ensure storm water management, construction of infrastructure to contain contact and waters.
- Ensure effective site supervision to ensure no blocking of storm water infrastructure and efficient storage of contact water.
- Use GAP internationally approved bio-degradable and/or environmentally friendly products.
- Enforce regular sampling of runoff water and Orange River to monitor pollution levels.

9 CONCLUSIONS

Overall, the development of the Oranjemund Irrigation Project would have a positive impact on the local community and economy as well as on the Namibian economy as a whole. In addition, the project would provide an invaluable contribution to food security in Namibia as a whole.

It was concluded from the assessments that construction and operational impacts would have minimal impact on air quality, noise levels, visual characteristics and heritage artefacts. Socio-economics were deemed to be positively impacted both directly and indirectly from both construction and operations at the site, but some negative impacts were identified, such as the in-migration of people into the town. The employment and skills development of local people is recommended.

Furthermore, the project alone should not have a significant impact on the abstraction from the Orange River, however, these calculations do not take into account any other planned abstraction along the river, which could affect the amounts of available water. The cumulative effects arising from the abstraction of water from the Orange River is not assessed and part of this study.

Mitigation measures have been identified and recommended both by the specialist assessment and by I.N.K Enviro Consultants cc to promote the positive impacts of the project, as well as to reduce the negative impacts to acceptable levels. An EMP was further developed which identifies potential impacts of the project during the construction and operation phases. The EMP is a legally binding document, which Galore and contractors onsite must adhere to.

I.N.K concludes that should Galore follow the actions (i.e. management and mitigation measures) provided in the EIA and EMP report, the project would have an acceptable impact on the surrounding physical and social environment.

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Desktop Water Resources Impact Assessment Report for the Proposed Horticulture Irrigation Project on Agricultural Plot 52 & 12 near Oranjemund in the //Karas Region

Document Version: **Final**

Prepared for: **I.N.K Enviro Consultants CC**

Prepared by: **Fredrika Shagama**

DOCUMENT INFORMATION

Title: Water Resources Impact Assessment Report for the Proposed Horticulture Irrigation Project on Agricultural Plot 12 & 52 near Oranjemund in the //Karas Region - A Desktop Specialist Study to the project's Environmental Impact Assessment

Prepared for I.N.K Enviro Consultants by:

Author:	**Fredrika N. Shagama**
Qualifications:	PhD. Student: Civil Engineering (Geotechnics) - in progress, VSB - Technical University of Ostrava, Czech Republic MSc. Geological Engineering (cum laude) with primary focus in Hydrogeology, VSB - Technical University of Ostrava, Czech Republic BSc. Geological Engineering, VSB - Technical University of Ostrava, Czech Republic
Professional Affiliations:	Environmental Assessment Professionals of Namibia (EAPAN) - Ordinary Member Practitioner (Membership No. 183) International Association of Hydrogeologists (IAH) - Full (online) Member, Membership No.139790 Namibian Hydrogeological Association (NHA) - Member
Signature:	

EXECUTIVE SUMMARY

Galore Trading cc (herein after referred to *Galore Trading* or the project *Proponent*) appointed I.N.K Enviro Consultants cc to undertake an environmental assessment of their proposed horticulture irrigation project near Oranjemund in the //Karas Region. The proposed site comprises of two agricultural plots (Plot 51 and Plot 12) with a combined surface area of 64 hectares (ha), located about 2 km east of Oranjemund Town. I.N.K Enviro Consultants further subcontracted Ms. Fredrika Shagama, an independent water consultant to conduct a desktop water resources impact assessment for the proposed project. The water resources report (this document) is an additional document to the environmental assessment documents.

The proposed project aims to abstract about 1 million cubic meters (1000 000 m^3) of water from the Orange River per year (annum).

Orange River is a Transboundary water source shared by four member states (Namibia, Botswana, South Africa and Lesotho). The four countries both have the responsibility of sustainably utilising the River water, to ensure that the water quantity (over-abstraction) and quality (pollution) is not compromised in the process. The Orange River water is protected by both the four countries' national Water Acts as well signed agreements between them. According to Heyns *et al* (2008), the joint management of shared water resources in the Southern African Development Community (SADC) is contributing to regional integration, socio-economic development, poverty alleviation and the protection of vital ecosystems. The SADC Protocol on Shared Watercourses is an instrument of international water law that entered into force in 2003. The overall objective of the Protocol is to foster closer cooperation between the SADC states for the coordinated management, protection and utilization of shared watercourses through the establishment of river basin organizations. Therefore, it is playing a pivotal role in guiding the establishment of institutional structures capable of jointly managing the scarce water resources in Southern Africa.

In Namibia, for any water abstraction to be used for commercial purposes, a permit to abstract and use that water should be obtained from the Department of Water Affairs and Forestry (DWAF) of the Ministry of Agriculture, Water and Forestry (MAWF). The abstraction and use of water resources is also listed under the Environmental Management Act No. 7 of 2007 and its 2012 Environmental Impact Assessment (EIA) Regulations as one of the activities that may not be undertaken without an environmental clearance certificate.

As part of fulfilling the requirements by the legislation that protects water resources in Namibia, an environmental assessment needs to be conducted in order to understand, assess and mitigate the potential impacts of the development on the local water resource. It is for this reason, that this desktop water resources risk / impact assessment report was compiled. The aim of the report was to assess the potential risks on water resources stemming from the proposed irrigation activities on the two agricultural plots.

The scope of this groundwater assessment was to review the applicable legal aspect of water resources management and protection, in terms of water over-abstraction and pollution. In addition, the physical conditions such as climate, geology, soils, hydrology and hydrogeology were reviewed in order to establish a baseline of the project area and aid in the assessment.

In addition, the irrigation water use and its impacts on the water quantity (abstraction) and quality (pollution) have been presented. The two impacts have also been assessed and water management and mitigation measures provided.

Recommendations

Given the assessment results, in order to protect and manage the water resources, the following management measures should be implemented (to mitigate over-abstraction):

- The abstraction of water should be controlled by Regulation (water abstraction and use permit). The regulation requires Water Authorities to: set objectives (abstraction targets), monitor and enforce compliance.
- The most important abstraction management plan is a water use license, which clearly stipulates the amount of water that should be abstracted from a water source and outlines all the conditions that need to be complied with during abstraction.
- Galore Trading should apply for and obtain a water abstraction and use permit from the Department of Water Affairs and Forestry at Ministry of Agriculture, Water and Forestry. Upon issuance of the permit, **it will be very crucial that the Proponent (Galore Trading) strictly adhere to the abstraction volumes given in their permit and if necessary use less water than the allocated volume in the water permit.**
- Upon issuance of the water use permit, an annual report including water flow and returns should be prepared and submitted to the responsible unit of the Department of Water Affairs and Forestry at the Ministry of Agriculture, Water and Forestry. This is used to monitor water use by the project and ensure that the Proponent is adhering to allocated water abstraction volumes.
- As an emphasis to the preceding point, annual reporting will demonstrate commitment from the Proponent, compliance and enables regulatory authorities to make informed decisions that minimize environmental impacts to groundwater and dependent ecological systems.
- Reduction of over irrigated areas. Irrigation should be restricted to actual field footprints only, i.e. watering / irrigation should only be done on water sections of the fields that really require it (water).
- Consider the application / utilization of water efficient irrigation methods.

- Project workers should be trained on water resourecs management, quality and conservation awareness
- Voluntary reduction in water use by users. The applicant should, if approved stick to the required and allocated volume of 1 000 000m^3/year and try by all means to use water efficiently and re-use where necessary.

Further abstraction management plans include:

- Regular review of an existing abstraction management plan to ensure that it can adapt to changing circumstances (given Namibia's ever changing climate) and publicly reporting on the plan's implementation.
- The re-use of the water used on some of the projects' activities should be encouraged.

Pollution measures that will need to be implemented and monitored are as follow:

- Proper waste disposal measures should be implemented on-site
- Irrigation systems should be designed and managed for zero or minimum deep percolation during the growing seasons to keep fertilizer and pesticides in the root zone as long as possible.
- Contamination of water by nitrates should be minimized by carefully controlling the timing and amount of nitrogen fertilizer applications according to crop needs, using slow-release fertilizers and other Best Management Practices (BMPs). This is done to keep nitrate in the root zones as long as long possible where it can be taken up the plant roots or denitrified. This is done to prevent groundwater pollution (alluvial aquifers).
- The use of biodegradable substances to control pests should be considered.
- Employ cropping systems that encourage low fertilizer usage.
- Use natural fertilizers to complement the use of organic manure.
- Water resources pollution awareness for all workers involved in both project phases should be implemented.
- Waste disposal site should be lined, so that soluble substances from the wastes do not get washed into the River or leach into groundwater when it rains.
- All run off materials such as hydrocarbons, waste water and other potential pollutants associated with the project should be contained on site in designated containers and disposed off at nearby sites in accordance to the municipal waste discharge standards, so that they do not reach water bodies (systems).

- Should fuel from vehicles and tanks spill on the soil, the polluted soil should be removed and replaced with clean soil. The removed soil should either be disposed off at a hazardous waste site or cleaned and returned to where it was taken from. This is to ensure that the contaminated soil is not washed downstream (through run-off) to the River and pollute the water.
- Drip trays for every heavy vehicle should be available on site at all times so as to contain hazardous waste.
- A bund wall (of same or larger volume as the fuel tank) should be constructed around the fuel tanks area. The bund wall is aimed at preventing accidental fuel spills or leaks from spreading to the soil and eventually to water sources.
- Spill control preventative measures should be put in place to manage soil contamination, thus minimizing the contamination from reaching water bodies during irrigation or run-offs.
- Should Galore Trading consider treating wastewater on-site, there will be a need have an agreement with the national water regulatory authority (Department of Water Affairs and Forestry) on the level of treatment of wastewater before discharging it into the general environment or directly into an irrigation conveyance system.

Conclusions

Based on the information gathered on site and from literature consulted, it was found that current water resources vulnerability to over-abstraction and pollution can be considered to be low to slightly moderate. It can be concluded that the water resources in the area is unlikely to be impacted by the proposed irrigation activities. This will however be determined by the effective implementation and monitoring of recommended management measures provided in this report. Further requirement to minimize the impacts is also that the water use permit is applied for from the national water regulatory body and that the permit holder (Galore Trading) adheres to the conditions set therein as well as compliance with legislation governing local and international water resources protection and management.

In order to protect groundwater, it is necessary for societies to recognize that water resources are finite and vulnerable, and find ways to reconcile the demands of human development with the tolerance of nature. The essential first step for making water use sustainable is awareness and knowledge of human impacts on the environment, specifically water resources.

It is essential for the monitoring programme to be established once the irrigation activities commence. This will greatly aid in understanding and ascertaining the extent of the anticipated irrigation impact on groundwater resources. This understanding will then lead to the implementation of further necessary action measures, in order to protect water resources and the general environment.

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List of Abbreviations

ºC: Degree Celsius

BMPs: Best Management Practices

m^3: million cubic metres

DWAF: Namibian Department of Water Affairs and Forestry

EEA: European Environmental Agency (EEA

EC: Electrical Conductivity

EMA: Environmental Management Act

Ha: Hectare

IAEA: International Atomic Energy Agency

IUCN: International Union for Conservation of Nature

JPWC: Joint Permanent Water Commission

km: kilometre

m: metre

m^3/day: cubic metre per day

m^3/hr: cubic metre per hour

MAWF: Ministry of Agriculture, Water and Forestry

mm: millimetre

Mm^3: million cubic metres

ORASECOM: The Orange-Senqu River Commission

SADC: Southern African Development Community

US EPA: United States Environmental Protection Agency

11 INTRODUCTION

Water is one of the most valuable yet vulnerable natural resources for people, animals and the general environment. It is therefore, very crucial to understand the impacts of water resources over-utilization (over-abstraction) and pollution (quality) on the surrounding environment.

According to the European Environmental Agency (EEA) (2018), water scarcity refers to long-term water imbalances, combining low water availability with a level of water demand exceeding the supply capacity of the natural system. Water scarcity is driven primarily by two factors:

- Climate, which controls the availability of renewable freshwater resources and seasonality in water supply; and
- Water demand, which is largely driven by population and related economic activities.

Although water scarcity often happens in areas with low rainfall, human activities aggravate the problem particularly in areas with high population density, tourist inflow, intensive agriculture and other water demanding industries.

Irrigation is mostly practised in arid to semi-arid zones, here referred to as dry lands, but is also known as humid areas. Dry lands are poor in precipitation and suffer tremendous climate variability from year to year, thus increasing the vulnerability of cultivated ecosystems.

The current drought experienced by Namibia's agricultural sector has left people looking for way on how to improve the food security in the country. In order to improve the human food production in the country, some business people have decided to establish irrigation schemes to produce crops, which inlcludes fruits and vegetables.

As one of the businesses, Galore Trading cc proposes to establish and operate a horticulture irrigation scheme near the Oranjemund Town. Given the current dry climate of Namibia, they intend on abstracting water for their operations from the Orange River.

Orange River is a Transboundary water source shared by four member states (Namibia, Botswana, South Africa and Lesotho). The four countries both have the responsibility of sustainably utilize the River water, to ensure that the water quantity (over-abstraction) and quality (pollution) is not compromised in the process. The Orange River water is protected by both the four countries' national Water Acts as well signed agreements between them. According to Heyns *et al* (2008), the joint management of shared water resources in the Southern African Development Community (SADC) is contributing to regional integration, socio-economic development, poverty alleviation and the protection of vital ecosystems. The SADC Protocol on Shared Watercourses is an instrument of international water law that entered into force in 2003. The overall objective of the Protocol is to foster closer cooperation between the SADC states for the coordinated management, protection and utilization of shared watercourses through the establishment of river basin organizations. Therefore, it is playing a pivotal role in guiding the establishment of institutional structures capable of jointly managing the scarce water resources in Southern Africa.

In Namibia, for any water abstraction to be used for commercial purposes, a permit to abstract and use that water should be obtained from the Department of Water Affairs and Forestry (DWAF) of the Ministry of Agriculture, Water and Forestry (MAWF). The abstraction and use of water resources is also listed under the Environmental Management Act No. 7 of 2007 and its 2012 Environmental Impact Assessment (EIA) Regulations as one of the activities that may not be undertaken without an environmental clearance certificate.

As part of fulfilling the requirements by the legislation that protects water resources in Namibia, an environmental assessment needs to be conducted in order to understand, assess and mitigate the potential impacts of the development on the local water resource. It is for this reason, that this desktop water resources risk / impact assessment report was compiled. The aim of the report was to assess the potential risks on water resources stemming from the proposed irrigation activities on the two agricultural plots.

11.1 Project Background and Location

The report has been prepared as part of the environmental assessment for the proposed construction and operation of a horticulture irrigation project in the //Karas Region. The project will be established and operated by Galore Trading cc on two agricultural plots referred to as Plot 52 and Plot 12 located about 2 km east of the Oranjemund Town. According to I.N.K Enviro Consultants (2019), Galore Trading intends to grow and produce fruits and vegetables in the early stages of the project, and possibly expand to various other crops, pending suitability instigations. The plot figures, i.e. 52 and 12 correspond with the actual sizes of these plots, meaning that the total surface area of the site is 64 hectares (ha). These two plots are shown in the locality map (**Figure 1**).

The water for the irrigation project is proposed to be abstracted from the Orange River (located ±1 km east of the project site) to the irrigation site via underground pipeline and with the use booster pumps near the River. Bulk irrigation water will be piped from the river to a series of booster pump stations located on the project area to supply the various irrigation systems. The amount of water required for the project is approximately 1 million (1 000 000) m^3 per year (I.N.K Enviro Consultants, 2019).

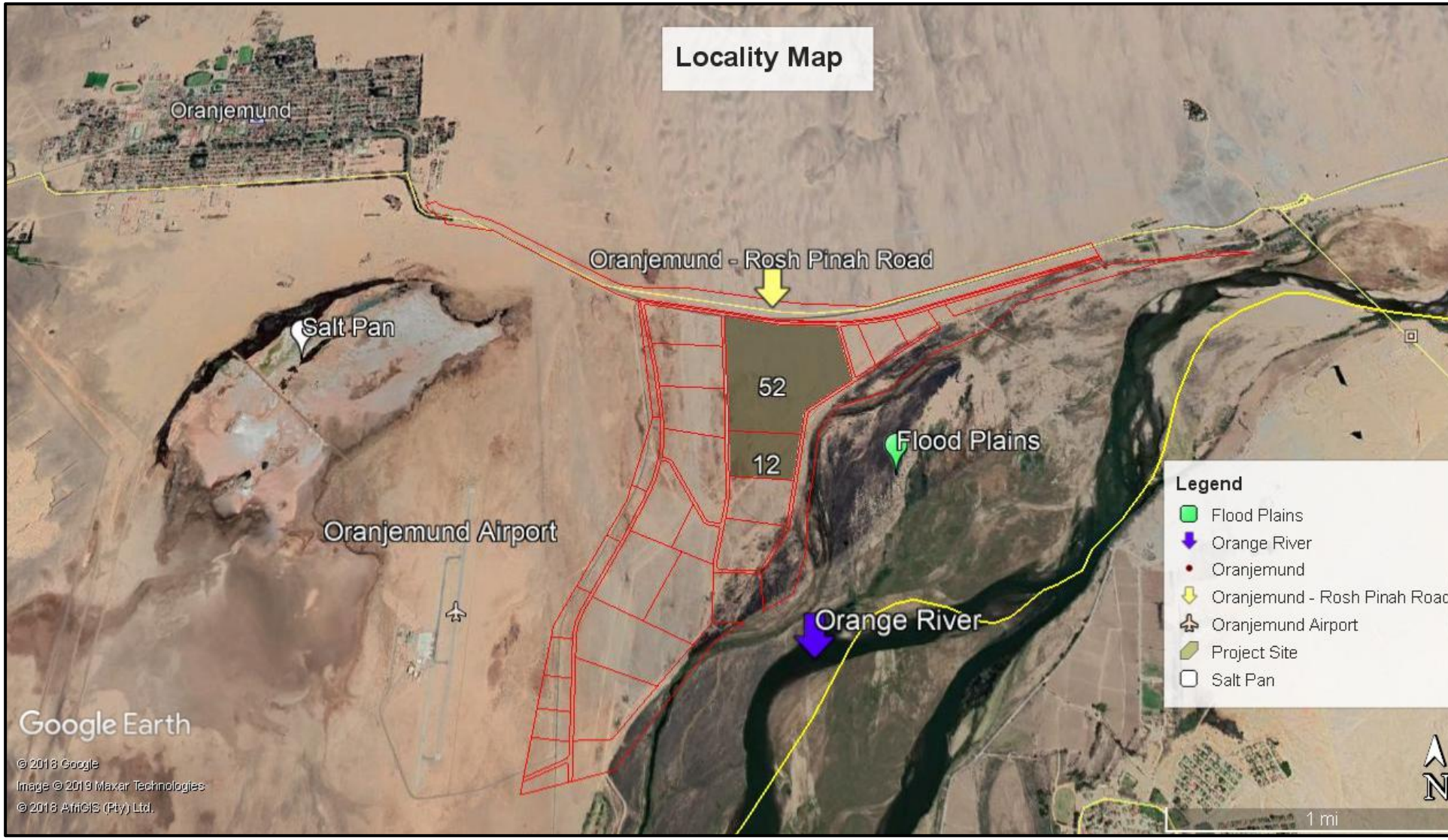

Figure 1: Location of the proposed horticulture irrigation site near Oranjemund in the //Karas Region

12 TERMS OF REFERENCE, SCOPE OF WORKS AND METHODOLOGY

12.1 Terms of Reference

There was no formal Terms of Reference (TOR) provided by I.N.K. For this reason, the study has been conducted based on the author's experience in preparing water risk/impact assessment studies and reports.

12.2 Scope of Works

The scope of work for this study is limited to the water resource impact assessment with a cursory look at the water source for the proposed project, in terms of quantity (abstraction) and quality (pollution). The scope of works for this study is presented below:

- Baseline assessment (desktop study);
- A review of legislation that governs water resources management and protection in Namibia, South Africa, Botswana and Lesotho, since the Orange River is a shared resource between the four countries;
- Determining (estimation of) the available water resources reserve and sustainable annual water volume abstraction;
- The proposed irrigation water use and its impacts on surrounding water resources quantity (abstraction) and quality (pollution); and
- Water resources impact assessment and recommendations on management.

12.3 Limitations of the Study

The following assumptions apply to this assessment:

- No site visit was undertaken by the author. The site information used in this report has been used as provided by I.N.K;
- It is assumed that the project information and data provided by I.N.K is correct and accurate and that all necessary information has been disclosed;
- It is also assumed that the relevant information obtained from different literature consulted by the author is accurate;
- This report has been due to limited data in the site area, compiled on a desktop level; and

- It is assumed that there will be no significant changes to the proposed activity or the affected water environment between the compilation of this report and implementation of the proposed (irrigation) activity that could substantially influence findings and recommendations with respect to mitigation and water resources management.

12.4 Methodology Employed

The methodology for this study was derived from some projects of similar nature that have been conducted by the author. The following stages were undertaken:

- Step 1: Desktop study - Reviewing of literature and legislation relevant to the study (baseline assessment). The data source for this project stage comprised of geological, hydrological, Hydrogeological maps and existing reports of similar or related studies conducted in the area.
- Stage 2: Impact assessment - The potential impacts of the project on the water resources (in terms of water over-abstraction and pollution) were identified, risk/impact assessed and practical mitigation measures recommended.
- Stage 3: Reporting - All the information obtained from I.N.K and literature review has been analyzed and presented in this document. This include; physical settings/conditions of the area, relevant maps, water balance and quality, risk/impact assessment, Orange River water analysis results and recommendations on water resources management. The recommendations will be incorporated into I.N.K's draft Environmental Management Plan (EMP) of the project.

The proposed horticulture irrigation project will be governed by certain water legislations. These legal requirements are presented under the following chapter (Chapter 3).

13 LEGAL FRAMEWORK FOR WATER RESOURCES USE, MANAGEMENT AND PROTECTION

The relevant legislations and legal requirements (national and international) governing the abstraction and use of surface water, specifically the Transboundary Water Resources (Orange River) are presented in the section below. The national legislations referred to above are general legal requirements set up by each of the four individual countries (for their own water resources within their counties) that share the Orange River. The four countries referred to herein are; Namibia, South Africa, Lesotho and Botswana. The international legislations are those that were adopted from agreements between or from outside the four countries.

According to the Orange-Senqu River Awareness Kit (Undated), it is widely recognised and accepted that countries within the Orange-Senqu River basin are affected by water scarcity. In order to allocate these resources to users effectively and equitably, there needs to be a strong legal basis governing water use and management. Water supply schemes, demand management, re-use, and recycling are important considerations for water management as is collaboration between inter-basin organisations. Abstraction permits, compulsory licensing and water-use authorisations are methods to determine and monitor water use and allocation. A typical licensing system requires a custodian of water resources who determines the allocation of these resources.

13.1 National Water Legislations

13.1.1 Namibia

The Namibian legislations that govern the use, management and protection of water resources and related activities are as follows:

- Water Act No. 54 of 1956;
- Water Resources Management Act No. 1 of 2013;
- Environmental Management Act No. 7 of 2007;
- Soil Conservation Act No.76 of 1969; and
- Public and Environmental Health Act No. 1 of 2015.

The Water Policy: National Water Policy White Paper, August 2000 (this laid the basis for the new Water Resources Management Act)

13.1.2 South Africa

The South African water legislations are as follows:

- Water Services Act No. 108 of 1997, with amendments;

- National Water Act No.36 of 1998, with amendments; and
- The Constitution of the Republic of South Africa 1996.

The Water Policy: National Water Resource Strategy - first edition, September 2004 effective

13.1.3 Lesotho

The relevant water legislations are listed below:

- Water Resources Act No.22 of 1978;
- Water Resources Regulations Act No.22 of 1980;
- Lesotho Highlands Development Authority Order No. 23 of 1986; and
- Lesotho Highlands Development Authority (Amendment) Act 2000.

The Water Policy: National Water Resources Management Policy 1999

13.1.4 Botswana

The relevant water legislations for Botswana are listed below:

- Waterworks Act 1962;
- Water Act 1968;
- Boreholes Act 1974; and
- Water Utilities Corporation Act 1976.

The Water Policy:

- National Water Resources Management Policy 1999 National Development Plan 9 (2003/4 – 2008/9) Chapter 9: Water Resources;
- Botswana National Conservation Strategy; Government Paper No 1 of 1990 (National Water Master Plan); and
- Assessment of the Status of Transboundary Natural Resources Activities in Botswana - IUCN Botswana 2003.

13.2 International Relevant Water Legislations

The international conventions and Treaties relevant to the use and management of the International (Transboundary) Watercourses, including the Orange River re as follows (according to Hiddema and Erasmus, 2007):

- United Nations Convention on the Law of the Non-Navigational Uses of International Watercourses, 1997 (has not yet entered into force);
- SADC Protocol on Shared Watercourses 1995;
- SADC Revised Protocol on Shared Watercourses 2000 (has now entered into force);
- Treaty on the Lesotho Highlands Water Project , 24 October 1986 with 6 Protocols;
- Agreement between Botswana and Namibia on the establishment of a Joint Permanent Water Commission (JWPC) 13 November 1990;
- Agreement between South Africa and Namibia on the establishment of a Permanent Water Commission 14 September 1992;
- Agreement between South Africa and Namibia on the Vioolsdrift and Noordoewer Irrigation Scheme 14 September 1992;
- Agreement between Angola, Botswana and Namibia on the establishment of a Permanent Okavango River Basin Water Commission (OKACOM) 15 September 1994; and
- Agreement between South Africa, Botswana, Lesotho and Namibia on the establishment of the Orange-Senqu River Commission (ORASECOM).

14 PHYSICAL CONDITIONS OF THE PROJECT AREA

In order to undertake a concise assessment and make informed conclusions on an environment, it is vital to understand its baseline (physical) conditions, i.e. pre-project conditions. The baseline conditions relevant to this assessment are briefly described below.

14.1 Climate

Oranjemund is considered to have a desert climate. Like many of the coastal towns in the country, Oranjemund's temperatures do not fluctuate but rather remain relatively average throughout the year. Fog occurs, on average, on more than 100 days per year at Oranjemund. It forms a moist cold air from the ocean and meets the hot dry air of the desert. The climate of Oranjemund is strongly influenced by the cold Benguela current which runs in a northerly direction along the coast, which in turn is driven by the South Atlantic anticyclonic climate system. Although the area is a desert, cool and foggy conditions occur most mornings and strong southerly winds are common in the afternoons (Africa Planning Forum, 2019).

The average rainfall of Oranjemund recorded for a period of ten (10) years, i.e. 2009 to 2019 is shown in the map below (**Figure 2**).

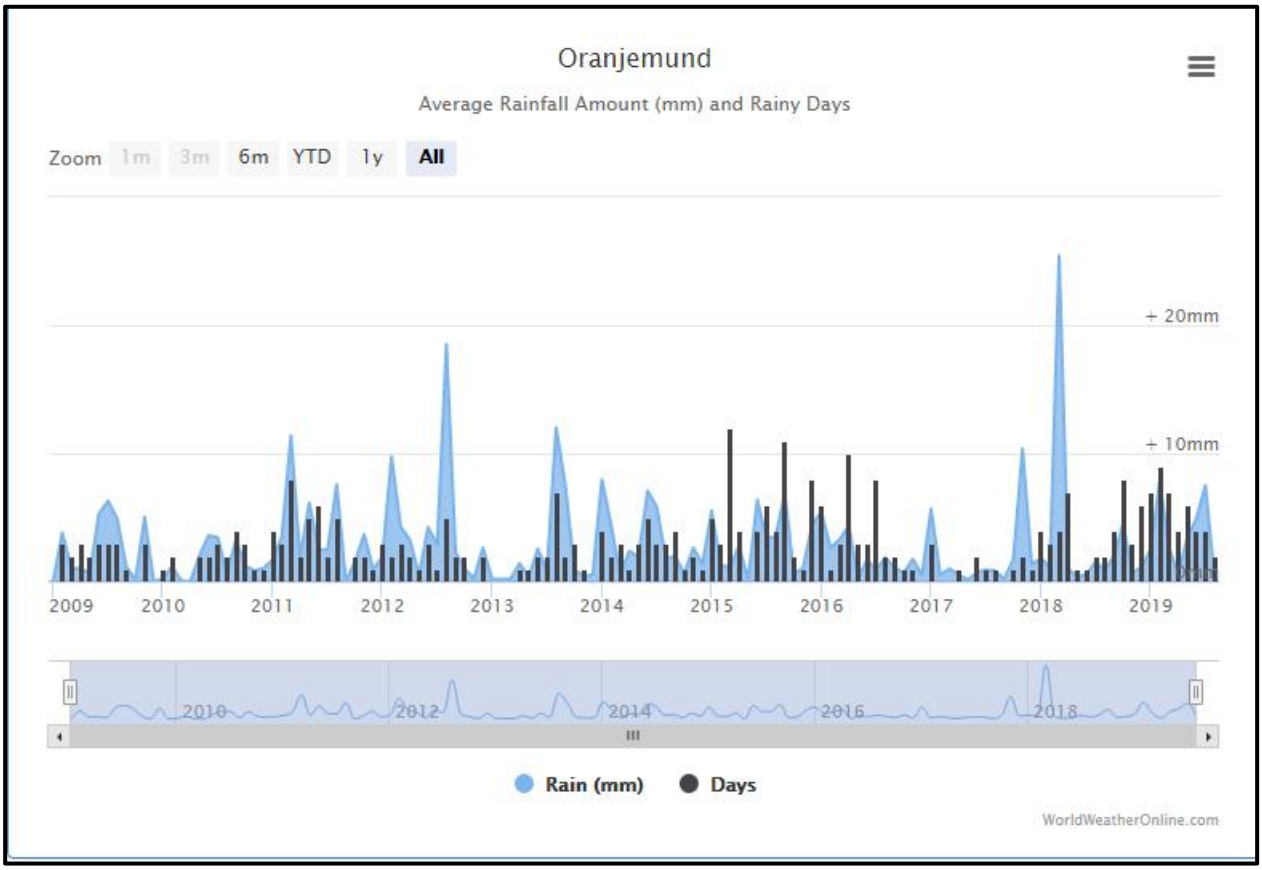

Figure 2: **The rainfall patterns in the Oranjemund area (World Weather Online, 2019)**

The precipitation is low in the lower part of the Orange River Basin. The mean annual precipitation (MAP) on the lower parts of the Orange River and the Fish rivers are below 100 mm. The MAP on the Orange River is shown in **Figure 3** below.

The mean temperature in Alexander Bay is 17.3ºC, ranging from 9ºC in July to 24ºC in January (monthly means). The potential evaporation is more than 2 800 mm/year in Vioolsdrift and downstream on the Orange River, with values higher than 2 600 mm/year in Alexander Bay. On the Fish River, potential evaporation is higher than 2 950 mm/year. Consequently, in average terms, the contribution of rainfall to the runoff of the Orange River downstream of Vioolsdrift and of the Fish River downstream of Ai-Ais is negligible (Fritsch and Troy, 2006).

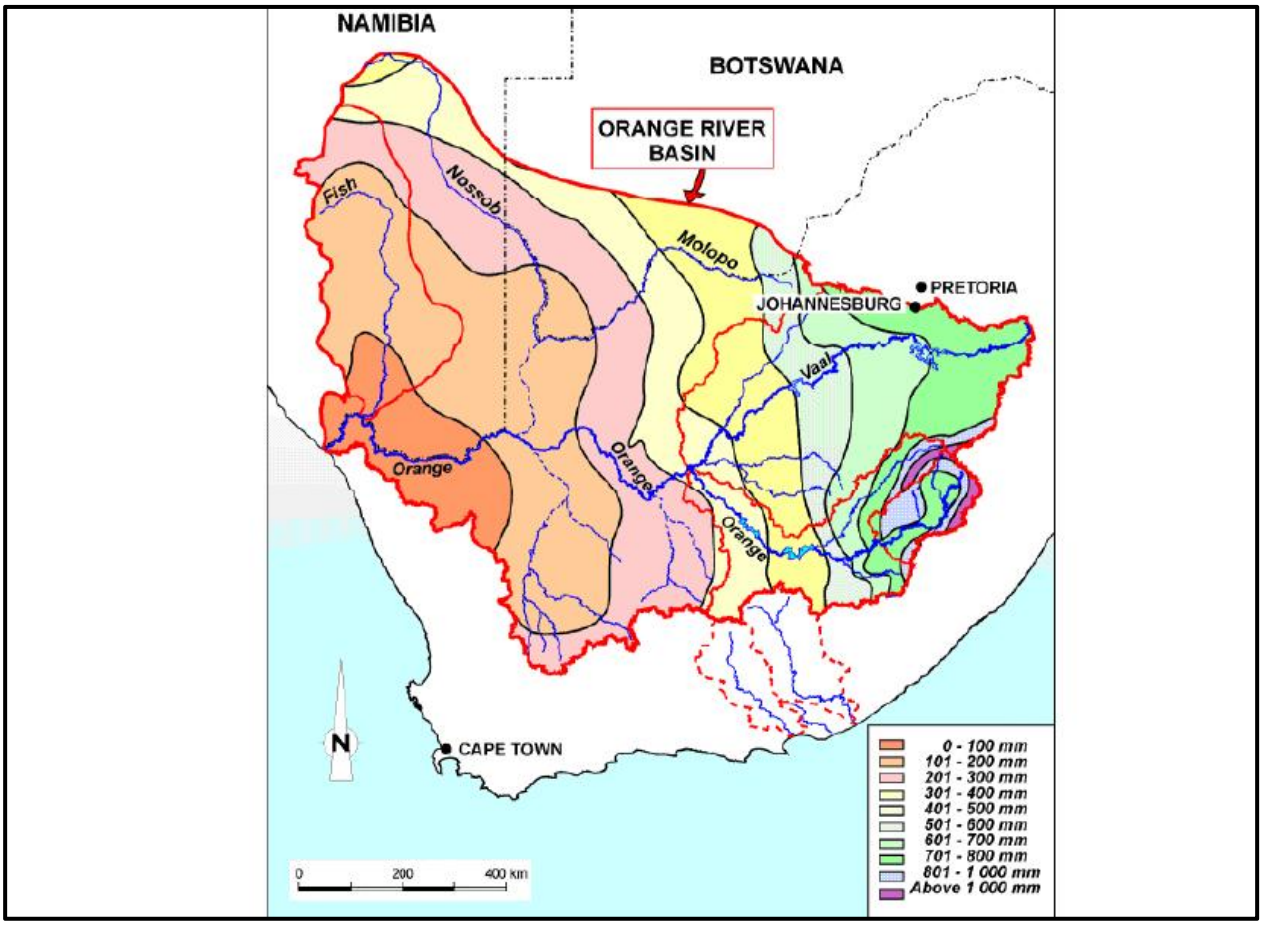

Figure 3: Mean annual precipitation on the Orange River Basin (edited after Fritsch and Troy, 2006)

14.2 Topography

According to Africa Planning Forum (2019), the Oranjemund area can be described as relatively flat with sparse vegetation. The town is located merely 20 meters above sea level on a virtually flat piece of terrain rock type found in the area is the Kalahari and Namib Sands which is largely dominated by sands. The elevation map of Oranjemund is shown in **Figure 4** below. The approximate location of the proposed project site is also displayed / marked as "***PS***" and the Orange River marked as "***OR***" (as per the arrow).

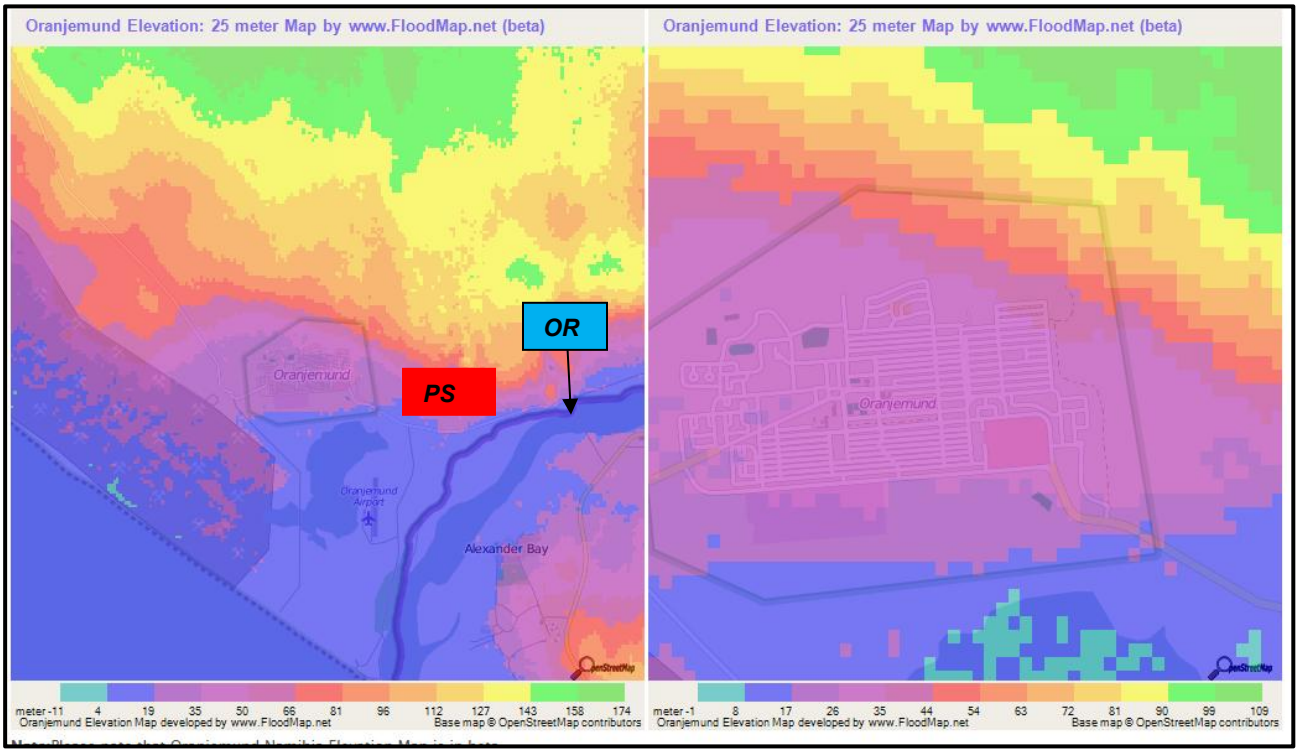

Figure 4: The elevation (base) map of the Oranjemund area (FloodMap.net, 2018)

14.3 Soil and Geology

The project site area is covered by the sandy soils of the Namib Desert. In the far west, the Namib is in a hyperarid climate, which severely limits productivity. Areas in the northeastern parts of the //Karas Region receive more rainfall but it drains through the soil rapidly, leaving little moisture for plants. Few nutrients are retained in the porous sand. These characteristics give the Kalahari sandy soils also low carrying capacities. The soils have a negligible amount of organic matter, but will store seeds until conditions become suitable for germination. The distribution of the soils is linked to the topography and wind direction in and around the study area with a common transition point along the major natural watercourse that runs from the north-west to south-east (GCS Water & Environmental Consultants, 2017).

In terms of the geology, the project (study) area is overlain by Namib sediments and overlain by carbonate rocks of the Kalahari Group. These Kalahari Group comprises of unconsolidated to semi-consolidated sand and gravel, locally calcrete and deeper bedrocks of marble, sandstone and quartzite.

14.4 Hydrology

All rivers are ephemeral, except for the Orange River with its extensive catchment in wetter South Africa and Lesotho. Total abstraction from the Orange River, for irrigation schemes, mines and towns, already produces a significant deficit in the mean annual runoff at the mouth, which classifies it as a Category D status (largely modified wetland with extensive losses of natural habitat and basic ecosystem functions. Ephemeral rivers in the Region include; Olifants, Nossob, Fish River, Zebra and Tsondab (GCS Water & Environmental Consultants, 2017).

The entire Orange Basin and relevant neighboring catchments have been divided up into 16 hydrological zones (**Figure 5**). Each zone includes a number of different time series files representing different sub-catchments within the hydrological zone. There are a total of 207 different hydrological files included in the systems models.

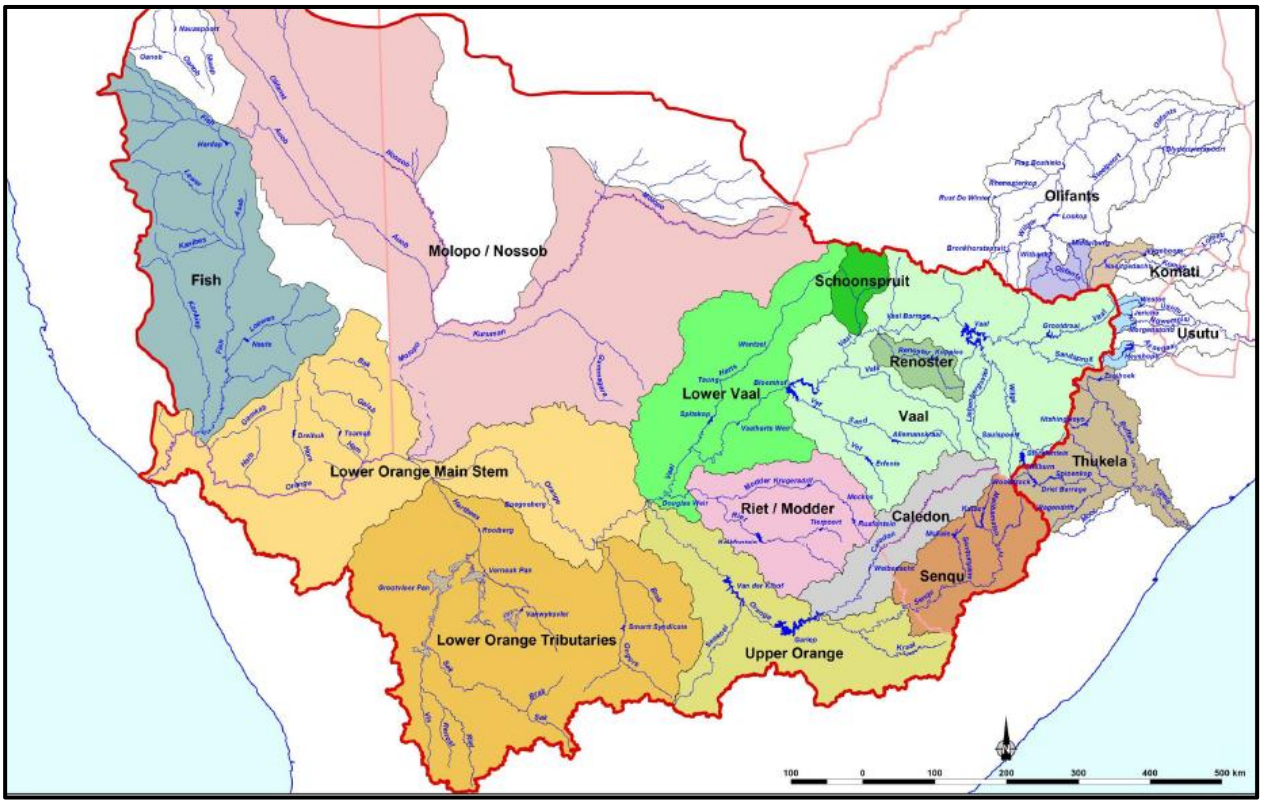

Figure 5: Orange River base map and main hydrological zones

A description of the hydrological zone is provided along with an explanation of its importance to the Orange system. A history of the development of the hydrology within the zone is included, presenting all modifications that have taken place over time. A description of the methodology used to prepare the final ORASECOM hydrology is also included for each zone.

An overall rating of the hydrology has been assigned to each zone. This rating has been developed using a scoring system representing a number of factors including the density of rainfall gauges over the zone, the availability of observed streamflow data within the zone and available information regarding landuse data in the zone necessary for calibration. The score is somewhat subjective; however, it does provide a comparable indication of the confidence in hydrology between zones (WRP Consulting Engineers Aurecon *et al*, 2013).

14.4.1 Orange River Water Use

The prediction of water requirements for purposes planning is based on the primary drivers of water demand, which are population growth and local economic growth. These two factors are intertwined to some extent, as economic growth may stimulate population growth as a result of migration from the rural areas or other urban area with a poor economy (Mahasa *et al,* 2015).

According to Mahasa *et al* (2015), South Africa uses 97% total water withdrawal from the Orange River thus making it the largest water user. It is further mentioned that although Lesotho contributes to over 40% of the stream flow, it only uses 1% of the water resources, further downriver outside the study area Botswana accounts for less than 1%, and Namibia uses about 2%. Agriculture is the main activity in the basin and this account for 61% of water demand in the area such that agriculture-inclined employment accounts for more than 50% of the basin's population.

The water resources of the Orange-Senqu River basin are primarily used for irrigation. Environmental flow requirements are also pretty high, while mining, industries, power generation and domestic consumption consume much less water. Water use differs from region to region; agriculture is the major user of water in the mid- to lower reaches of the Senqu/Orange River, while industrial, mining and domestic uses predominate in the upper reaches of the Vaal River (Orange-Senqu River Awareness Kit, undated). **Figure 6** below shows the water use by country and industry.

	Lesotho	South Africa (Upper & Lower Orange River)	Botswana (groundwater only)	Namibia (Surface Orange River only)
Agriculture, forestry and fishing	19,27	1 828	0,51	42,78
Mining and quarrying	1	9	—	1,43
Manufacturing and Services	21	54	0,11	—
Households	24	106	0,51	—
Subtotal, all economic uses	43,27	5 199	1,12	44,22
Ecological requirements	No value given	1 743	No value given	No value given

Figure 6: Water use by country and industry, 2000 (Mm^3)

As seen in the Figure above, South Africa is the largest user of water from the Orange-Senqu River basin; it uses 97% of total annual use, including environmental flows and inter-basin transfers. Lesotho uses 1%, Namibia 2% and Botswana uses <1% of the total flow in the Orange-Senqu River basin.

14.4.1.1 Water Use Allocation for Namibia

In Namibia, applications for Water Abstraction Permits are made to the Ministry of Agriculture, Water and Forestry (MAWF). Currently water allocations exist for urban, mining and irrigation purposes. For urban and mining applications, the volumes are based on the predicted water demands of each development and the permits are issued accordingly. The permit allocations for irrigation are based on the area to be irrigated. Namibia has an agreement with South Africa to abstract at least 70 Mm^3/year according to Aquastat Namibia 2009 from the Orange River (Orange-Senqu River Awareness Kit, Undated).

14.4.2 Orange River Water Quality

The quality and quantity of water from rivers is highly variable, this is because of seasonal droughts or floods. The quality of ground water also varies greatly (South African Department of Water Affairs and Forestry, 1996).

In order to establish a baseline water quality, two water samples were taken from the Orange River close to the project site in July 2019 (and analysed in August 2019 by Analytical Laboratory Services). The full chemical analyses of these water samples are attached as **Appendix A** of this report (*Orange River Sample A* and *Orange River Sample B*). Upon consultation with the officials at the Water Environment Department at MAWF on available Standards on Irrigation Water, the Consultant was informed that Namibia does not have such Standards of its own, therefore the South African Guidelines (Agricultural Use: Irrigation) are used to compare and check compliance of irrigation water in Namibia.

An addition of two independent different water samples were also collected and analysed for human consumption (analysed in June 2019 NamWater Laboratory Services). These samples were compared against the Namibian Drinking Water Quality Standards). These analyses results are presented under **Appendix B** (Sample *DS53621* and *DS53620*).

14.4.2.1 Water Sample Quality Compliance to Standards and Guidelines

The Orange River water samples analyzed were compared to the South African Guidelines (Agricultural Use: Irrigation) to check compliance of irrigation water in Namibia. The samples were found to be compliant. The independent water samples were also found to be compliant with the Standards they were compared to.

The water quality can only remain acceptable and good for as long as the recommended environmental (water) mitigation (management) measures are effectively implemented and monitored. Therefore, Galore Trading should implement the provided measures in order to protect water quality.

14.4.3 Vulnerability of Water Resources to Over-abstraction

The vulnerability of the River water to over-abstraction may be difficult to predict for a Transboundary resource such as Orange River being shared between four countries. However, should the four countries not adhere to their annual water abstraction allocations (as in their water use agreements), given the already felt impact of climate change worldwide, the Orange River may be vulnerable to very low water levels as a result of over-abstraction. This impact would not only be felt by people, but by the biodiversity relying on the same water source.

14.4.4 Vulnerability of Water Resources to Pollution

In areas where extensive agricultural activities are practised, the aspects of water pollution and water protection have increasingly become an issue in most parts of the world.

The surface water bodies / resources are vulnerable to pollution via surface run-offs from irrigated project sites where environmentally unfriendly fertilisers and hydrocarbons or wastewater is handled. Possible pollution may not only originate from the agricultural sites, but the nearby towns and other land uses within proximity of the surface water bodies, such as the Orange River.

In a hyper arid environment like Oranjemund, the impact of surface run-offs from rainfall is less likely as the amount of the magnitude of rainfall is low (not enough to cause flooding from site). Surface run-offs from the project site to the Orange River may only occur through excessive use of water for irrigation. This means water applied to the irrigated site areas may carry fertilisers and waste on the site soils and wash them downstream (to the River), depending on the amount fertilisers and waste found on the ground surface. This likelihood is low and therefore the vulnerability of the water resources to pollution is low to slightly moderate. The vulnerability risk to pollution was assessed based on the climate (rainfall), site soil type, distance from site to the River and probability/likelihood.

14.5 Hydrogeology

The project area falls under the Southern Namib and Naukluft groundwater basin and according to Koch *et al* (2011), groundwater potential over most of the //Karas Region is classified as low, with only about 30% having moderate potential. Limited water availability in the Namib Desert presents the single largest constraint on development. Mean rainfall is less than 100 mm per year, meaning that sufficient rain to recharge the aquifers only falls in some years.

There are two types of aquifers in the groundwater basin, namely the shallow alluvial primary aquifers along the Orange River, and a variety of deeper hard rock secondary (heavily karstified) aquifers. Alluvial aquifers are generally only recharged by surface water (the Orange River), and are usually considered part of that water resource. Christelis and Struckmeier (2001) added that the occurrence of exploitable groundwater resources in the Namib Desert is closely linked to the existence of alluvial aquifers created by perennial, ephemeral or even fossil rivers. The only abundant source of groundwater in the Sperrgebiet is the alluvial aquifer along the Orange River, which provides a secure supply to Oranjemund.

With that said, the Orange River is the permanent source of water in the Region to towns (such as Rosh Pinah and Oranjemund), mines as well agricultural and tourism projects.

14.5.1 Water Use in the Orange River Alluvial Aquifers: Oranjemund Area

The town of Oranjemund is supplied with water from the Fehlman well. The Fehlman well is a concrete lined shaft with a diameter of 2.9 m and is 17.05 m deep. The well is fed by ten laterals (40 m long) pipes which are radiating horizontally from the bottom of Fehlman well. Water fills these laterals directly from the aquifer (alluvial aquifers fed by the Orange River). The Fehlman well is the biggest supply of freshwater to the town of Oranjemund, producing approximately 800 m^3 (800 000 litres) of water per hour. The condition of the well laterals and the level of the aquifer, which is recharged by the Orange River, influence the water table in the well (GCS Water & Environmental Consultants, 2016).

There are eight production wells in this area that are responsible for the augmentation of bulk water, located on the north bank of the Orange River. These wells under optimum conditions produce 640 m^3 (640 000 litres) of water per hour.

14.5.1.1 Water Quality: Orange River Alluvial Aquifers

In 2016 GCS Water & Environmental Consultants analysed the available water data. The available borehole information at the time obtained from Namdeb's old groundwater database showed that, twelve (12) boreholes had been profiled for Electrical Conductivity (EC) between January 1999 and December 2003. Conductivity readings have also been taken from the taps at the (water) production boreholes. Conductivity readings are taken to give early warning of possible deterioration in the quality of the water supplied. The EC values of the monitoring boreholes water increased with depth, ranging from 0.10 to 0.60 mS/m.

There was found to be a big gap in water monitoring data over the years whereby either there is no data for a specific year or there is very little data for certain years. Based on the available monitoring boreholes' data analyzed, the water quality of the alluvial aquifer is classified Group A, which is water of excellent quality and good for human consumption.

15 PRELIMINARY SURFACE WATER RESERVE DETERMINATION

15.1 Water Balance Calculations

The water balance, also known as water budget, of a water resource is defined as a function of inflow/outflow (inputs and outputs to the system) resulting from head differences between the aquifer and its surroundings. A water budget describes the various components of the hydrologic cycle of the area of interest. The general equation for calculating a water balance of a water system is given below:

Inflow = Outflow ±∆Storage

Whereby,

- ∆S is known to be change in storage;
- Input: precipitation, surface water, water inflow, and recharge; and
- Outputs: evaporation, groundwater outflow, groundwater abstraction.

According to Michigan Land and Water Management Division (2010), the most difficult part of computing the water budget is locating data that allows accurate estimation of the net surplus or deficit. If the project depends primarily on surface runoff, years with normal, below normal, and above normal rainfall can be identified, and that information can be used to determine the surface runoff under those three climate conditions.

If the expression on the right-hand side of the equation (final result of the calculations) is positive, storage will increase and the water level in the area of interest will rise. A positive change in storage is often termed a surplus, while a decrease in storage is termed a deficit. A water budget is calculated for a specified period of time. Permanent projects may be evaluated using daily or monthly data, with the resulting net surplus or deficit is expressed as a seasonal or annual value (Michigan Land and Water Management Division, 2010). The local water balance is presented in **Table 1** as follows:

Table 1: Summary of criteria for calculating local water balance or budget

Parameter	Value
Rainfall Recharge (m^3/day):	Undetermined
Existing abstraction (m^3/day):	Undetermined
Proposed / future abstraction for Galore Trading irrigation activities (m^3/day):*	-2 739.73
Total output / losses from the River (m^3/day)	Undetermined
Surplus (+) or Deficient (-) Amount: Recharge minus total output (m^3/day)	Undetermined

* ***- proposed irrigation water requirements (2 739.76 m^3/day or 1 000 000 m^3/year)***

The water balance of the project area (Orange River) cannot be determined due to the unavailability / lack of required water data and uncertainties in shared water resources between the four member states. Therefore, the River reserves estimations cannot be determined.

Regardless, upon revision of the national River water abstraction allocation (see Section 4.4.1.1 above) by the Namibian DWAF and allocation to Galore Trading, it is recommended that they only abstract the 2 739 m^3/day amounting to their desired 1000 000 m^3/year for their operations. This volume will need to be maintained not only to sustain the irrigation activities at the project site but other users abstracting from the River. Furthermore, this optimum volume is not only set to sustain the water users (people and animals), but the general ecosystem that depends on the same resource as well.

The potential impacts stemming from the proposed irrigation activities are described and assessed under the following chapter covers this issue (impact on groundwater).

16 HORTICULTURE IRRIGATION WATER USE AND ITS IMPACTS ON WATER RESOURCES

16.1 Impacts on Water Resources: Over-abstraction

The over-abstraction of water from any water source (be it groundwater or surface) does not only affect the surrounding users (humans), but the general environment too that depends on the same water resource. Over-abstraction of surface water may impact the ecological integrity of a river and wetlands and results in significant losses of habitat and biodiversity. The lowering of the water levels in a river (upstream) also means a decrease in water levels for downstream water users. Not only the decrease in water levels, but weakening of water flow in the rivers.

16.2 Impact on Water Resources: Pollution

In irrigation schemes, fertilisers, herbicides and pesticides used in crop production or irrigation schemes can also be considered some of the major pollutants of water bodies and the wider environment in their vicinity of the site, if not handled properly. These pollution sources may pose a threat to water quality for the water users, especially downstream of the River that rely on the same water resource. Potential impacts on groundwater need to be identified, assessed and adequately mitigated if they cannot be avoided.

Irrigation can also cause upstream and downstream problems, such as water shortages downstream, drainage problems, and the drainage of contaminants. Thus, in order to prevent soil salinisation, it is very important to assess the impact of irrigation on the water environment in arid and semi-arid regions, such as Namibia. The potential sources of pollution (leading to poor water quality) associated with the irrigation activities are as follow:

- The introduction of fertilizers, herbicides and pesticide onto agricultural land to improve the soil and crop growth can lead to pollution of surface systems and eventually water systems. This potentially happens through the percolation of these substances from soils into water or run-off from the project site surface to the nearest surface water bodies.
- Another potential source of water pollution is potential sewage leaks from the proposed site septic tanks.

Pollution in irrigation projects does not only affect the people and environment (water and other components), but the irrigation water users too. According to the South African Department of Water Affairs and Forestry (1996), irrigation water users may experience a range of impacts as a result of changes in water quality. The impacts of poor water quality on the irrigators are as follows:

- Reduced crop yield (as a result of increased salinity or the presence of constituents that are toxic to plants);

- Impaired crop quality (this may result in inferior products or pose a health risk to consumers);
- Impairment of soil suitability (as a result of the degradation of soil properties and accumulation of undesirable constituents or toxic constituents); and
- Damage to irrigation equipment (corrosion or encrustation).

The assessment of the two risks (over-abstraction and pollution) is presented under the following chapter.

17 WATER RESOURCES IMPACT ASSESSMENT AND MANAGEMENT MEASURES

17.1 General Concept of Impact (Risk) Assessment

Generally, an environmental risk occurs when there is a hazard (e.g. process, activity or substance) that can result in a harmful impact on the surrounding environment. The part of the environment which is, or could be, affected is known as a receptor. Receptors include humans, flora and fauna, the built environment and water resources (controlled waters). The presence of a hazard alone does not constitute a risk; a risk is only present if there is a means by which the hazard can impact on sensitive receptor(s). The connection between the hazard and receptor is known as a pathway, and all three elements together constitute a source-pathway-receptor (S-P-R) linkage (SRK, 2006). The three elements are briefly defined as follows:

- **Source (or hazard)**: a substance capable of causing pollution or harm.
- **Receptor (or target)**: something which could be adversely affected by the contaminant.
- **Pathway**: a route by which contaminants can reach the receptor.

Environmental risk assessment is the process whereby S-P-R linkages are identified and evaluated. If any of the three elements are absent then there is no complete linkage and thus no unacceptable risk. The magnitude of a risk is a function of the consequences of risk and the likelihood that such rick will occur.

The risk assessment for the two issues (over-abstraction and pollution) that may impact the water resources during the duration of the irrigation activities on site is presented below.

17.2 Water Impact Assessment (Over-abstraction)

17.2.1 Source

Excessive abstraction or damming of rivers affects the flow, which in turn affects water chemistry, sediment transport and average temperatures. This has an impact on aquatic biota and the human beings that rely on the water and biota for their livelihoods and well-being (Orange-Senqu River Awareness Kit: Environmental Flows, Undated).

The sources in this aspect will be the over-pumping of water for irrigation, which will affect people and the River environment.

The proposed irrigation activities by Galore Trading will require about one million cubic meters (1 000 000 m^3) of water from the Orange River per year (annum). This is quite a significant amount of water by a single activity and therefore, this may impact the water resource, if not properly managed.

17.2.2 Pathway

The pathway of this impact was determined by the amount of water abstracted and water flow direction. The nature and extent of activities that require water along the Orange River would cause rapid decrease in River levels through excessive and long-term unmanaged over-abstraction. It is difficult to assess the impact of the proposed irrigation activities, given the fact that there are already existing similar projects and other activities along the River in the other three countries abstracting from the River. With that said, the impact of the project on the water resources (quantity) will be cumulative.

17.2.3 Receptor

The people downstream of the project site and surrounding environmental components like vegetation can be considered potential receptors. Excessive abstraction of water at the project site may lead to the decrease in River water levels downstream.

17.2.4 Orange River Water Risk Assessment

The potential impact on the groundwater resources in the area can be considered low to moderate as this impact is more of a cumulative type (an addition to; what was done, currently done and will be done in the future). The implementation of groundwater monitoring plan and adherence to the water permitting conditions and legislations are essential to manage groundwater and prevent over-abstraction.

17.3 Water Impact Assessment (Pollution)

Irrigation may have a variety of impacts on water. If irrigation water with a load of fertilisers and pesticides is discharged on surface water, it may have a negative impact on these waters (disturbing aquatic systems), but also on areas reached by these surface waters. Enclosed systems, because of limited contact with the surroundings, generally have minor impacts on the natural environment. Small reservoirs can improve the availability of irrigation water, however they may also - depending on the subsoil and the quality of the irrigation water - cause contamination of groundwater (HTSPE Limited, 2013).

17.3.1 Source

The potential sources of pollution to water resources from the project will be agricultural run-offs (from on-site fertilizers, pesticides and herbicides) that may be used to enhance crop growth on the irrigated fields. Further sources will include wastewater generated on site, septic and fuel tanks and other pollution sources related to irrigation activities. The pollution would potentially impact downstream water users that rely on the River for water supply.

17.3.2 Pathway

Polluted or poor quality water will travel from the potential sources at the project site further downstream of the Orange River. Fertilizers and other site pollutants can be transported to downstream receptors by River water flow, therefore prone to pollution risk related to irrigation activities. The nature and extent of pollution will also depend on the amount of fertilizers applied to the soil on the irrigated fields. This will also depend on the amount of mishandled waste spilled on the soil that eventually washes into the water (resources) bodies.

17.3.3 Receptor

The downstream water users (people and animals) of the Orange River from the project site and surrounding environmental components like vegetation can be considered potential receptors to this impact (pollution). A sudden decrease in water quality during the irrigation project especially downstream would be linked to the irrigation activities. However, a thorough study would need to be undertaken in order to confirm that the experienced water quality issue is solely attributed to the proposed irrigation activities or with other irrigation activities carried out on the South African side of the Orange River.

The implementation of water monitoring plan and adherence to the water permitting conditions and legislations are essential for the prevention and management of groundwater pollution.

17.4 Water Demand Management Plans

The following management plans are recommended and should be effectively implemented and monitored by Galore Trading in order to mitigate and properly manage the potential risks on water stemming from their irrigation activities.

17.4.1 Orange River Abstraction Management Plans

Over-abstraction of both surface and groundwater resources can have severe impacts on people, animals and the general environment. Therefore, it is very important to manage water abstraction. If too much of it is abstracted, the water source may become depleted, especially during the dry years experienced by Namibia in the recent years. The depletion of water sources such as a River like Orange has adverse impacts such as deterioration of water quality. Not only water quality issue but a potential decrease in groundwater levels because alluvial boreholes are recharged by the River. Over-abstraction of water resources may also have negative impacts on the surrounding environment, especially the natural ecosystem (biodiversity) supported by the Orange River. It is therefore important to manage the abstraction from the River.

The management action plans provided below are to be implemented in order to mitigate the impacts of the project on water quantity (over-abstraction):

- The abstraction of water should be controlled by Regulation (water abstraction and use permit). The regulation requires Water Authorities to: set objectives (abstraction targets), monitor and enforce compliance.
- The most important abstraction management plan is a water use license, which clearly stipulates the amount of water that should be abstracted from a water source and outlines all the conditions that need to be complied with during abstraction.
- Galore Trading should apply for and obtain a water abstraction and use permit from the Department of Water Affairs and Forestry at Ministry of Agriculture, Water and Forestry. Upon issuance of the permit, **it will be very crucial that the Proponent (Galore Trading) strictly adhere to the abstraction volumes given in their permit and if necessary use less water than the allocated volume in the water permit.**
- Upon issuance of the water use permit, an annual report including water flow and returns should be prepared and submitted to the responsible unit of the Department of Water Affairs and Forestry at the Ministry of Agriculture, Water and Forestry. This is used to monitor water use by the project and ensure that the Proponent is adhering to allocated water abstraction volumes.
- As an emphasis to the preceding point, annual reporting will demonstrate commitment from the Proponent, compliance and enables regulatory authorities to make informed decisions that minimize environmental impacts to groundwater and dependent ecological systems.
- Reduction of over irrigated areas. Irrigation should be restricted to actual field footprints only, i.e. watering / irrigation should only be done on water sections of the fields that really require it (water).
- Consider the application / utilization of water efficient irrigation methods.
- Project workers should be trained on water resourecs management, quality and conservation awareness
- Voluntary reduction in water use by users. The applicant should, if approved stick to the required and allocated volume of 1 000 000m^3/year and try by all means to use water efficiently and re-use where necessary.

Further abstraction management plans include:

- Regular review of an existing abstraction management plan to ensure that it can adapt to changing circumstances (given Namibia’s ever changing climate) and publicly reporting on the plan’s implementation.
- The re-use of the water used on some of the projects' activities should be encouraged.

17.4.1.1 Water Resource Sustainability

The water resource can only be sustained if water management plans as provided above are put in place. This will need to be implemented through a continued and effective close cooperation between the four member states utilising the Orange River water. However, given the fact that the proposed irrigation in question is a Namibian owned, it is vital that the Namibian water regulatory authority allocate the required project water needs in line with the international/ORASECOM agreements, thus ensuring water resources management and sustainability of the available resource. It is also very crucial that the project Proponent adheres to the allocated water thresholds, in order to support water resources sustainability, not only for their project but other surrounding water users.

Upon assessing the hydrology of the project area based on the available information, the impact of pollution on the water resources is considered low to moderate.

17.4.2 Pollution Management Plans

In order to avoid and or minimize the impact of pollution stemming from the irrigation fields and related activities, the following measures are recommended:

- Proper waste disposal measures should be implemented on-site.
- Irrigation systems should be designed and managed for zero or minimum deep percolation during the growing seasons to keep fertilizer and pesticides in the root zone as long as possible.
- Contamination of water by nitrates should be minimized by carefully controlling the timing and amount of nitrogen fertilizer applications according to crop needs, using slow-release fertilizers and other Best Management Practices (BMPs). This is done to keep nitrate in the root zones as long as long possible where it can be taken up the plant roots or denitrified. This is done to prevent groundwater pollution (alluvial aquifers).
- The use of biodegradable substances to control pests should be considered.
- Employ cropping systems that encourage low fertilizer usage.
- Use natural fertilizers to complement the use of organic manure.
- Water resources pollution awareness for all workers involved in both project phases should be implemented.
- Waste disposal site should be lined, so that soluble substances from the wastes do not get washed into the River or leach into groundwater when it rains.
- All run off materials such as hydrocarbons, waste water and other potential pollutants associated with the project should be contained on site in designated containers and disposed off at nearby sites in accordance to the municipal waste discharge standards, so that they do not reach water bodies (systems).

- Should fuel from vehicles and tanks spill on the soil, the polluted soil should be removed and replaced with clean soil. The removed soil should either be disposed off at a hazardous waste site or cleaned and returned to where it was taken from. This is to ensure that the contaminated soil is not washed downstream (through run-off) to the River and pollute the water.
- Drip trays for every heavy vehicle should be available on site at all times so as to contain hazardous waste.
- A bund wall (of same or larger volume as the fuel tank) should be constructed around the fuel tanks area. The bund wall is aimed at preventing accidental fuel spills or leaks from spreading to the soil and eventually to water sources.
- Spill control preventative measures should be put in place to manage soil contamination, thus minimizing the contamination from reaching water bodies during irrigation or run-offs.
- Should Galore Trading consider treating wastewater on-site, there will be a need have an agreement with the national water regulatory authority (Namibian Department of Water Affairs and Forestry) on the level of treatment of wastewater before discharging it into the general environment or directly into an irrigation conveyance system.

THREATS, LIMITATIONS AND OPPORTUNITIES

The apparent abundance of water in the Orange River is misleading, since both the water quantity and quality is declining. The main threats to the water resource are heavy water demands by mines and the risk of pollution from mines and agricultural activities (Koch *et al*., 2011). The Orange River water quality is getting poorer from the return flows from irrigation farms (in South Africa and Namibia) which carry high loads of pesticides and leached fertilisers. The pesticides and fertilisers in the water threaten the ecological integrity of the Orange River as an important linear oasis through the arid surroundings, particularly the mouth which is recognised as a wetland of international importance.

Furthermore, the water quality of the River does not only affect the River ecology, but also the alluvial aquifers when it is fed by the polluted water from the River. In other words, the water quality and quantity status of the aquifers depend on the status of the Orange River's water and any change that affects the River, it affects the aquifers too.

According to Namdeb (2003b), water is not metered in Oranjemund; therefore residents are unaware of the water usage. This is a potential threat to the water resource because the water use is not managed. During midyear (winter) water consumption by Oranjemund is some 400 000 m^3 (400 million of litres) of water per month and rising drastically in the summer months where highest daily water consumption recorded for 2002 was 21 123 m^3 (30th December). The total water usage for the month of December 2002 was 513 932m^3 (513 932 000 litres) indicating an increase of more than 100 million litres of water. It was also noted the River levels also dropped from 2.95 metres (30th September 2002) to 0.65 metres (3rd January 2003). This implies if the town depletes the water held in the aquifer and the River at its lowest level which is the case in the summer months, the Oranjemund community will be faced with a water shortage (GCS Water & Environmental Consultants, 2016).

17.5 Data Gap

The lack and unavailability of data precludes getting an overall and clear presentation of water data in the area. Not only the lack and unavailability is concern, but also the age of the existing and available data. In other words, some of the data is found to be too old (out-dated) that it may not necessarily correspond with the current area conditions.

Insufficient water quality data and data management: During the analysis of the water quality data collected in the Orange River Basin (by Coleman and Niekerk (2007), a number of issues related to data collection were identified and these include:

- Data collection is fragmented between countries and institutions.
- The locations of the water quality monitoring points are not optimal.
- The water quality variables analysed for are not consistent between institutions.
- The sampling frequency and the water quality variables analysed for are insufficient to manage the Orange River Basin successfully.
- There is no single or standard data management and reporting systems.

In agreement with Coleman and Niekerk (2007), the following needs to be done to address the gap in data:

- A coordinated monitoring programme needs to be developed to address:
    - The establishment of monitoring objectives
    - The monitoring point locations
    - Frequency of monitoring and water quality variables to be tested for

- The current network of continuous water quality monitoring stations needs to be reviewed and expanded. In designing the system consideration should be given to real time management of both water quality and quantity
- Database systems, data management and reporting
- Institutional responsibilities and implementation program

Legal issues: In South Africa, indications show that about 240 million m^3/year of illegal water use is due to unauthorised withdrawals or violations of water use licenses. The status of water use for irrigation in the Orange-Senqu Basin also shows that insufficient information exists such that work needs to be done to understand the potential for increased efficiency of water use, taking into account issues pertaining to crop type, soil type and technological options (Mahasa *et al*, 2015).

18 RECOMMENDATIONS AND CONCLUSIONS

18.1 Recommendations

Given the assessment results, in order to protect and manage the water resources, the following management measures should be implemented (to mitigate over-abstraction):

- The abstraction of water should be controlled by Regulation (water abstraction and use permit). The regulation requires Water Authorities to: set objectives (abstraction targets), monitor and enforce compliance.
- The most important abstraction management plan is a water use license, which clearly stipulates the amount of water that should be abstracted from a water source and outlines all the conditions that need to be complied with during abstraction.
- Galore Trading should apply for and obtain a water abstraction and use permit from the Department of Water Affairs and Forestry at Ministry of Agriculture, Water and Forestry. Upon issuance of the permit, **it will be very crucial that the Proponent (Galore Trading) strictly adhere to the abstraction volumes given in their permit and if necessary use less water than the allocated volume in the water permit.**
- Upon issuance of the water use permit, an annual report including water flow and returns should be prepared and submitted to the responsible unit of the Department of Water Affairs and Forestry at the Ministry of Agriculture, Water and Forestry. This is used to monitor water use by the project and ensure that the Proponent is adhering to allocated water abstraction volumes.
- As an emphasis to the preceding point, annual reporting will demonstrate commitment from the Proponent, compliance and enables regulatory authorities to make informed decisions that minimize environmental impacts to groundwater and dependent ecological systems.
- Reduction of over irrigated areas. Irrigation should be restricted to actual field footprints only, i.e. watering / irrigation should only be done on water sections of the fields that really require it (water).
- Consider the application / utilization of water efficient irrigation methods.
- Project workers should be trained on water resourecs management, quality and conservation awareness.
- Voluntary reduction in water use by users. The applicant should, if approved stick to the required and allocated volume of 1 000 000m^3/year and try by all means to use water efficiently and re-use where necessary.

Further abstraction management plans include:

- Regular review of an existing abstraction management plan to ensure that it can adapt to changing circumstances (given Namibia's ever changing climate) and publicly reporting on the plan's implementation.
- The re-use of the water used on some of the projects' activities should be encouraged.

Pollution measures that will need to be implemented and monitored are as follow:

- Proper waste disposal measures should be implemented on-site.
- Irrigation systems should be designed and managed for zero or minimum deep percolation during the growing seasons to keep fertilizer and pesticides in the root zone as long as possible.
- Contamination of water by nitrates should be minimized by carefully controlling the timing and amount of nitrogen fertilizer applications according to crop needs, using slow-release fertilizers and other Best Management Practices (BMPs). This is done to keep nitrate in the root zones as long as long possible where it can be taken up the plant roots or denitrified. This is done to prevent groundwater pollution (alluvial aquifers).
- The use of biodegradable substances to control pests should be considered.
- Employ cropping systems that encourage low fertilizer usage.
- Use natural fertilizers to complement the use of organic manure.
- Water resources pollution awareness for all workers involved in both project phases should be implemented.
- Waste disposal site should be lined, so that soluble substances from the wastes do not get washed into the River or leach into groundwater when it rains.
- All run off materials such as hydrocarbons, waste water and other potential pollutants associated with the project should be contained on site in designated containers and disposed off at nearby sites in accordance to the municipal waste discharge standards, so that they do not reach water bodies (systems).
- Should fuel from vehicles and tanks spill on the soil, the polluted soil should be removed and replaced with clean soil. The removed soil should either be disposed off at a hazardous waste site or cleaned and returned to where it was taken from. This is to ensure that the contaminated soil is not washed downstream (through run-off) to the River and pollute the water.
- Drip trays for every heavy vehicle should be available on site at all times so as to contain hazardous waste.

- A bund wall (of same or larger volume as the fuel tank) should be constructed around the fuel tanks area. The bund wall is aimed at preventing accidental fuel spills or leaks from spreading to the soil and eventually to water sources.
- Spill control preventative measures should be put in place to manage soil contamination, thus minimizing the contamination from reaching water bodies during irrigation or run-offs.
- Should Galore Trading consider treating wastewater on-site, there will be a need have an agreement with the national water regulatory authority (Department of Water Affairs and Forestry) on the level of treatment of wastewater before discharging it into the general environment or directly into an irrigation conveyance system.

18.2 Conclusions

The aim of this report was to assess the potential risks/impacts of the proposed irrigation activities on the water resources. The assessment has been undertaken on a desktop level, i.e. based on information gathered on site by I.N.K and reviewing of previous studies done on the project area by the water consultant.

Based on the information gathered on site information and from literature consulted, it was found that the water resources vulnerability to over-abstraction and pollution can be considered to be low to slightly moderate. It was also can be concluded that the water resource impact by the proposed irrigation activities will be a cumulative since there are already existing similar activities and other land uses that utilise the Orange River.

The water resources management and protection will need to be done by implementing the management measures provided herein. The Proponent will also need to manage and protect water resources will by complying with the applicable legislation governing water resources protection and management.

In order to protect the water resources, it is necessary for societies to recognize that water resources are finite and vulnerable, and find ways to reconcile the demands of human development with the tolerance of nature. The essential first step for making water use sustainable is awareness and knowledge of human impacts on the environment, specifically on water resources.

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