ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED ESTABLISHMENT, OPERATION AND DECOMMISSION OF A LANDFILL SITE IN THE LISELO AREA, ZAMBEZI REGION

PREPARED

FOR

KATIMA MULILO TOWN COUNCIL

30 NOVEMBER 2021

PROJECT DETAILS

Report Title	**Proposed Establishment, Operation and Decommission of a Landfill Site in Liselo Area**
Proponent	The Katima Mulilo Town Council Private Bag 5009 Ngweze
EA Consultants	Namib Consulting Services CC P. O. Box 96093 Windhoek
EAP	Siyamana Mulele +264 85 694 9740 namibconconsulting@gmail.com
Date	November 2021

COMPILED BY

Namib Consulting Services CC
Geoscience and Environmental Consultants

Table of Contents

Executive Summary i

Abbreviations vii

Chapter 1 1

1. Introduction 1

1.1 Background 1

1.2 Project Scope and Terms of Reference 2

1.3 The EIA Process Approach 4

Chapter 2 5

2. Description of the Locality 5

2.1 Site Location 5

2.2 Background to the Site 6

2.3 Land Ownership 7

Chapter 3 9

3. Description of Current and Future Activities 9

3.1 Current Waste Management Practices 9

3.1.1 Guiding Framework 9

3.1.2 Waste Management Operational Practices 11

3.1.3 Limitations and Opportunities in the Current Waste Management System 15

3.2 Objectives of New Waste Management Approach 16

3.3 Future Operational Configuration 19

3.3.1 Landfill Classification system 20

3.3.2 Pre-Construction Phase Activities 22

3.3.3 Construction Phase Activities 24

3.3.4 Operational Phase Activities 31

3.3.5 Decommission Phase 37

3.4 Site Lifespan 39

3.5 Need and Desirability of the Project 39

3.6 Project Alternatives 40

3.6.1 Alternative Site 40

3.6.2 Alternative Activity 41

3.6.3 No-Go Alternative 42

3.6.4 Go-ahead alternative 43

3.6.5 Decision on Alternatives 43
Chapter 4 45
4. Review of Legal Framework 45
Chapter 5 49
5. Description of the Receiving Environment 49
5.1 Climate 49
5.1.1 Temperatures 49
5.1.2 Precipitation 50
5.1.3 Evaporation 50
5.1.4 Wind Direction and Speed 51
5.2 Topography 52
5.3 Hydrology 53
5.4 Geology and Soils 54
5.5 Hydrogeology 55
5.6 Biodiversity 56
5.6.1 Fauna 56
5.6.2 Flora 56
5.7 Cultural Heritage 56
5.8 Land Uses 57
5.8.1 Regional Integrated Land Use Plan 58
5.8.2 Local land use applications 58
5.9 Socio-Economics 58
5.9.1 Demography 59
5.9.2 Health and Education Facilities 59
5.9.3 Employment and economics activities 60
Chapter 6 61
6. Public Participation 61
6.3.1 Newspaper notices 62
6.3.2 Poster Notices 62
6.4.1 Liselo Community Meeting 64
6.4.2 Katima Town Hall Meeting 64
6.4.3 Regional Authorities Consultations 65
Chapter 7 68

7. Impact Assessment 68
7.1 Identification of impacts 68
7.2 Impact Assessment Methodology 69
7.3 Impact Evaluation and Mitigation Controls 72
7.4 Hydrogeology Specialist Assessment 82
7.4.1 Study Approach and ToRs 82
7.4.2 Assessment Results 82
7.5 Cumulative Impacts 83
Chapter 8 84
8. Environmental Management Plan 84
Chapter 9 85
9. Conclusion and Recommendations 85
9.1 Conclusion 85
9.2 Recommendations 85
References 86
List of Annexures 87

List of Figures

Figure 1 The EIA Process Approach 4
Figure 2 Location of project site 5
Figure 3 Ground outlook of the burrow pit 6
Figure 4 Waste disposal at residences and businesses 12
Figure 5 Type of vehicles used for waste removal 13
Figure 6 Waste management hierarchy 17
Figure 7 General waste cell base design requirements 21
Figure 8 Site layout plan 23
Figure 9 An illustration of an envisaged sorting shelter 26
Figure 10 Wood chipper and leaves shredder machine 28
Figure 11 Illustration of prefabricated incinerator unit 29
Figure 12 Conceptual water flows inside the burrow based on surface terrain 30
Figure 13 Illustration of a lined HDPE pond 30
Figure 14 Conceptual evaporation/storm water pond 31
Figure 15 Illustration of waste separation provision at public spaces around town 32
Figure 16 Well managed waste placement in preparation for removal 33
Figure 17 Waste skip provision for garden and building rubble 33
Figure 18 Proponents new waste containers rollout initiative 34
Figure 19 Illustration of Waste trucks specialized for waste skips 35
Figure 20 Illustration of sorting and packaging of waste at sorting shelter 36
Figure 21 General waste cell landfilling approach 37
Figure 22 Average annual temperature in Namibia 49
Figure 23 Rainfall pattern over the Zambezi region 50
Figure 24 Evaporation pattern over the Namibian landscape 51
Figure 25 Wind direction and speed for Katima Mulilo 52
Figure 26 Topography relief of the area around Katima Mulilo 53
Figure 27 Clay sediment layers underlying the brownish sand/loamy overburden. 55
Figure 28 Land uses in the surroundings of the project site 57
Figure 29 Proposed Regional land use plan 58
Figure 30 Notice placements at various places in local area and town 63
Figure 31 Liselo public consultation meeting 64
Figure 32 Prepared community hall meeting 64

List of Tables

Table 1 Report Structure outline 3
Table 2 Description of the waste management hierarchy measures 18
Table 3: Activities envisaged for the Site at different phases 19
Table 4 Site area allocation to different onsite facilities 23
Table 5 Identified stakeholders 61
Table 6 Newspaper Notices information 62
Table 7 Comments and responses at public consultation meeting 66
Table 8 Impact identification on natural resources 68
Table 9 Impact evaluation parameter description 70
Table 10 Impact significant description 71

Executive Summary

1. Introduction

Namib Consulting Services CC was appointed by the Katima Mulilo Town Council as an independent EAP to undertake an Environmental Impact Assessment (EIA) process towards submitting an application for an ECC for the proposed activity; the establishment, operation and decommission of a landfill site in the Liselo Landfill area.

This process comes after the Proponent had previously operated two dumping sites. The first site located in proximity to the Zambezi Vocational Training Centre towards Katima farm and the second site located behind Puma Fuel Station along the B8 Highway to Kongola. Both sites were subjected to compliance orders and subsequently instructions for closure after issues around compliance were unresolvable. This necessitated the proponent to look for an alternative site for waste management and reaching out to the MTA for assistance after constrains of finding a suitable site to apportion within townlands. The MTA in accordance with communal land allocation protocols availed a site in area of Liselo for the envisaged activity. This report therefore is towards ensuring that utilization of the site is in accordance with legislative requirements but also to achieve desired improvement to waste management whilst achieving both environmental and social safeguards but also accrue benefits derived from implementation.

2. Site Description

The proposed project site is a "brownfield" that previously served as a burrow pit for mining gravel material used in the construction of gravel roads in the region. the site is located approximately 5 kilometers southwest of the town of Katima Mulilo, along the B8 highway (Trans-Caprivi Highway) in the Liselo area. It takes a further distance of 2.5 kilometer off the main highway at Liselo Primary School, northwards to reach the site.

The apportioned site measures eight (8) hectares in area and situated in a landscape characterized by crop fields, and natural vegetation, with the nearest permanent residence some 1.5km away.

3. Project Description

The project entails the establishment of a new landfill on a site, including all related facilities and structures.

3.1 Description of Current Operational Configuration

It is evident from the closure of the two previous sites that the proponent's waste management practices although supported by an adequate guiding framework, they are not aligned to contemporary approaches to solid waste management for local authorities. The concept of 'operating a dumping sites' is more prominent in the description of the operation of the previous sites.

3.2 Description of the New Operational Configuration

Recognizing the inadequacy in the previous operations, the proponent has set to ensure that future solid waste management practices is aligned with principles of integrated solid waste management, engraining the waste management hierarchy in operations at all possible steps of the process. The desired approach is to induce practical techniques that embrace reuse and recycling and the concept of landfilling relative to dumping site. The associated activities to actualize these aspirations are described in subsequent sections.

3.2.1 Waste Description and classification

Waste generated by the Katima Mulilo Town and surrounding areas is mostly general waste, thus envisaged landfill site is a classified as general (G), with maximum rate of deposition (MRD) in the range of 61.99 to 70.85 tons per day, thus characterized as small (i.e. S) and not required to have a leachate management system in accordance with the MR2 requirements.

3.2.2 Strengthening the Administrative and legal framework

The existing guiding instruments in the waste management process are adequate to implement an effective waste management system; however, development of a long term waste management strategy can be helpful to sustain this approach into the future.

3.2.3 Envisaged Activities

The envisaged activities in the various phases include;

Phase	**Envisaged activity**
Pre-Construction Phase (Site preparation)	o Site layout planning o Site demarcation and marking off areas
Construction phase	o Construction of boundary fence o Site earthworks o Construction of support facilities, waste handling and treatment facilities
Operation Phase	o Waste disposal at source o Waste collection/removal at source o Transportation of waste to the landfill site o Offloading, handling and treatment of waste at landfill site o Maintenance of support structures
Decommission Phase	o Stakeholder engagement o Demolishment of redundant structures o Cleaning and landscaping of the area o Closure/site aftercare

4 Project Motivation

Prior being allocated a site by the traditional authority, the proponent had reached a dire state with no site available for waste management and wall waste accumulating in town and subsequent widespread illegal dumping within townlands and the surroundings. The condition on the outskirts of the town quickly became a health hazard awaiting. To quickly arrest the situation and prevent further environmental and human health deterioration it became critically important that KMTC establishes a new landfill. This provides the critical need for these efforts towards operation of the envisaged site.

5 Public Consultation Process and Outcomes

The public consultation process is an indispensable step in the EIA process, critical at establishing existing viewpoints, opinions, concern and advices about the envisaged activity. This step in the EIA process was prudently engaged to accrue its value to the project. Engagement of the communities of Liselo area, the local sub-Khuta, the traditional and regional authorities was critical to this project as the main stakeholders with interest or affected by the envisaged activity. At the various engagement platforms, issues raised centered around dissatisfaction with process for the TA's allocation of the piece of land, lack of local beneficiation and adverse effects on groundwater and safety of the local communities as among the highest concerns. The raised issues are typical of those identified in the impacts assessment process and addressed in the mitigation plan.

6 Impact Assessment and Mitigation

Any project has adverse and beneficial impacts and thus the aim of impact mitigation is to ensure that adverse impacts are minimized to acceptable levels or eradicated whilst beneficial impacts accrued.

6.1 Adverse Impacts

The significant adverse impacts identified in the impact evaluation process are;

- Dust generation
- Clearing of protected vegetation
- Littering of the landscape
- Safety and health of workers in all phases of the activity implementation
- Pollution of groundwater from potential leakage or spills of oils or fuels from vehicles
- Release of noxious emissions from vehicles onsite
- Denying people and livestock access to water within the burrow site
- Luring of aggressive and problematic wildlife animals
- Creased presence of vermin, pests and flies
- Generation of odour and smoke
- Groundwater pollution from generation of leachate from landfilled waste

6.2 Beneficial impacts

The proposed development will have the following benefits:

- Reduce and eliminate risks of mismanaging of general and inert waste from the town and surroundings
- The Landfill Site Recycling activities will contribute towards sustainable waste management on site.
- Create employment for skilled and semi-skilled people during the various phases of the activity.
- Site utilization is some form of rehabilitation of the derelict site
- Safeguard human health and safety of town residents and surrounding communities

7. Hydrogeology Specialist Assessment

Hydrogeology assessment was undertaken to establish baselines data of the site and further assess the potential adverse impacts of the envisaged activity on both the subsurface resources and associated social role. The area has high groundwater potential with associated good quality for human consumption. The groundwater water levels although shallow remain at reasonable distance to allow attenuation of contaminants, complementary to design requirements for the site.

8. Environmental Management Plan

An EMP was developed for significant adverse impacts to ensure that these are mitigated to manageable levels. Critical to these control measures is ensuring that the roles and responsibilities are assigned, leaving no ambiguity for implementation. The devised control measures align with widely accepted principles in mitigating significant impacts from new landfill sites, but even further provide some contemporary measure in handling and treatment of solid waste in an integrated approach.

9. Conclusion and Recommendations

The report concludes that establishing a landfill site has several adverse impacts to the environment and society in the local and surrounding landscape. However, the same activity when implemented derives beneficial impacts in economic opportunities to communities and but also environmental gains in that widespread degradation are limited to specific sites where more focused attention can be exerted to ensure containment to manageable levels. Critical to such projects is to ensure that adequate measures for environmental protection and safeguarding human health and safety are implemented as per environmental management plans, whilst ensure accountability.

Cognizant of the above, the EAP recommends sanctioning of the envisaged activity premised on full commitment and implementation of EMP taking robust step towards bridging the fragmented relations between the community and the proponent. The current site presents the most suitable site for utilization for the envisaged activity within a radius of 20km around Katima Mulilo.

Abbreviations

CBD	: Central Business District
EAP	: Environmental Assessment Practitioner
ECC	: Environmental Clearance Certificate
EIA	: Environmental Impact Assessment
EMP	: Environmental Management Plan
ISWM	: Integrated Solid Waste Management
KMT C	: Katima Mulilo Town Council
MEFT-DEA	: Ministry of Environment, Forestry and Tourism Department of Environmental Affairs
MTA	: Mafwe Traditional Authority
NSWM	: National Solid Waste Management Strategy
ZRC	: Zambezi Regional Council
ZRLB	: Zambezi Regional Land Board

Chapter 1

1. Introduction

1.1 Background

The Katima Mulilo Town Council (KMTC) hereon referred 'the Proponent' acquired a site envisaged for establishment and operation as a waste management facility. The closure of the old waste sites compelled the Proponent to find a suitable area to establish a waste management facility. However, faced with limited suiting sites within the boundaries of the town to apportion, it was resolved to approach other stakeholders to assist in this endeavor. The Proponent engaged the Mafwe Traditional Authority (MTA) after consultation with the sub-Khuta of Liselo to request for a site for the envisaged activity. The positive engagements led the Traditional Authority identifying and apportioning a site in the Liselo area for this envisaged activity.

Cognizant of the experiences with previous dumping sites, the Proponent has committed to ensure that those past experiences do not recur, therefore, compliance to governing legislation to establish and operate the new site is one of the highest priority set towards its utilization. Moreover, the Proponent is committed towards assuring residents and community in the surroundings of the site that matters of public health and safety are of high regard to the operation of the new landfill site inclusive of environmental considerations.

The Environmental Regulations (GN No. 30 of 2021) of the Environmental Management Act (Act No 7 of 2007), lists activities that may not be undertaken without an environmental clearance certificate (ECC). Under Section 2, Waste management, treatment, handling and disposal is listed as one such activity, further prescribed under subsection 2.1 as 'the construction of facilities for waste sites, treatment of waste and disposal of waste'.

Therefore, to realize the commitments set, the Proponent appointed Namib Consulting Services CC to carry out an environmental impact assessment (EIA) process towards obtaining an ECC. The Consultants are to assist optimize the operation of the site aligning with national and internationally recognized best practices and fundamental principles in

waste management. This report therefore is complementary of an application submitted to the office of the environmental commissioner for an ECC in compliance with legislative requirements.

1.2 Project Scope and Terms of Reference

In Section 8 of the Schedule of the Environmental Regulations (GN No. 30 of 2012), the scope of an EIA is set out. Moreover, the same scope sets out a guide as to the terms of reference and the extent of the work required from an environmental assessor. The scope ensures that the reports that will be submitted provides necessary information required by the Office of the Environmental Commissioner to make an informed decision about the project. The scope is sets out as follows;

- a description of the proposed activity;
- a description of the site on which the activity is to be undertaken and the location of the activity on the site;
- 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;
- an identification of laws and guidelines that have been considered in the preparation of the scoping report;
- details of the public consultation process
- 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;
- 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;
- terms of reference for any detailed assessment
- a draft management plan

The terms of reference for the environmental assessment practitioner (EAP) is concurrently set out above as to the extent of required detailed information to meet the prime objective of this project. This report is structured as in Table 1 below to meet the above stated requirements.

Table 1 Report Structure outline

Component	**Topic**
Chapter 1	Introduction
Chapter 2	Description of the locality/site
	Property ownership details
Chapter 3	Description of Current and Proposed Activities
	○ Current Operational Configuration
	○ Envisaged Operational Configuration
	The need and desirability of the proposed activity
	Project Alternatives
Chapter 4	Review all relevant legislative and regulatory requirements
Chapter 5	Description of the receiving environment
	Specification for specialist studies
Chapter 6	Details the Public Participation Process
	○ Stakeholder Identification
	○ Public Meetings
	○ Public Notices
	○ Summary of Issues and feedback
Chapter 7	Impact Assessment
	○ Impact identification process
	○ Impact Description
	○ Impact Significance Assessment methodology
	○ Impacts Evaluation
	Impact mitigation
	Specialist assessment
Chapter 8	Environmental management plan
Chapter 9	Conclusions and recommendations

1.3 The EIA Process Approach

The Environmental Assessment Policy (1995) sets out the process for an EIA project. This process will not be recited here, however a layout of how the required steps of the process were undertaken to meet regulatory requirements is outlined. The diagram below summarizes the steps that undertaken on this project.

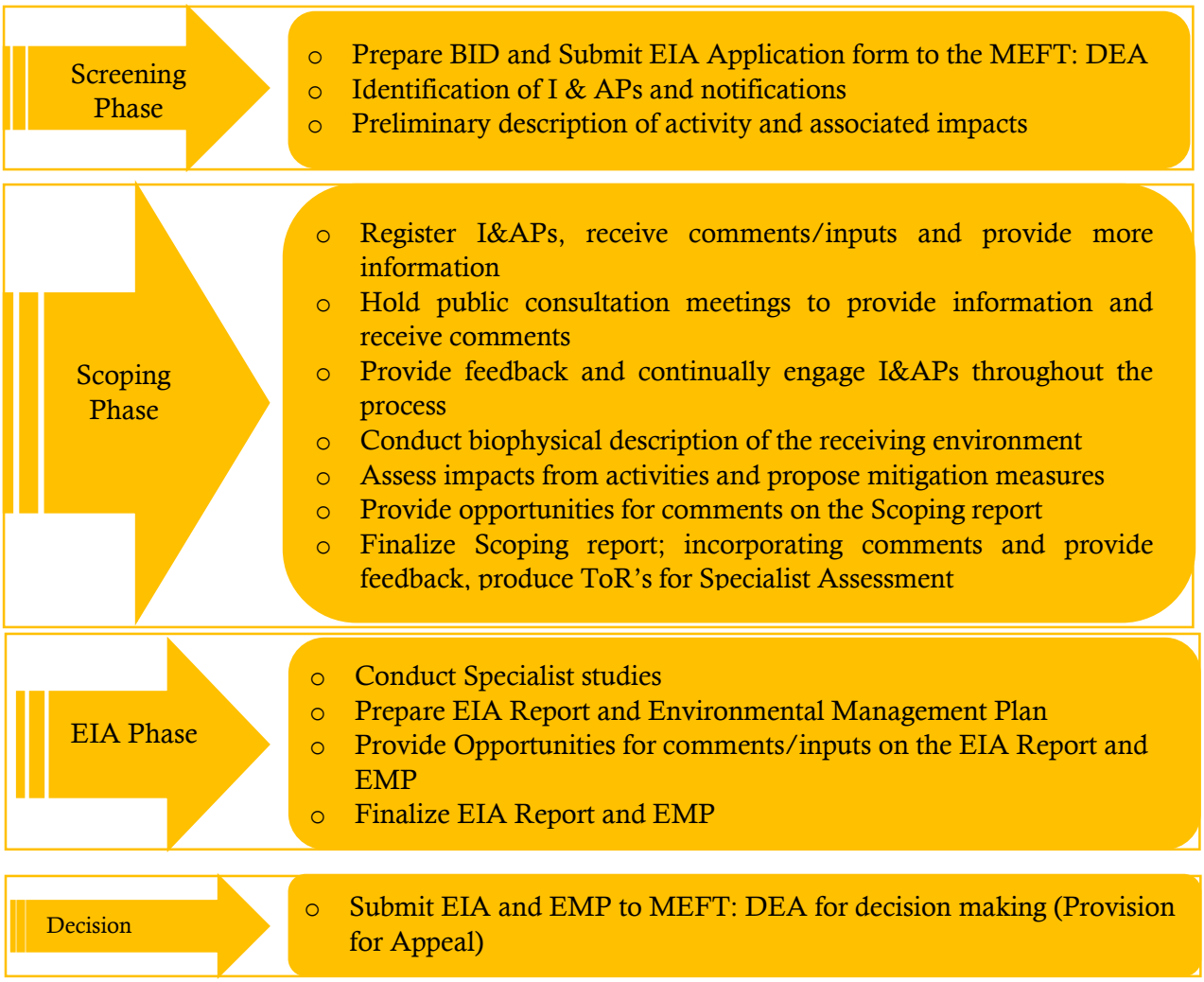

Figure 1 The EIA Process Approach

Chapter 2

2. Description of the Locality

2.1 Site Location

The site apportioned the Proponent for the proposed waste management facility is located approximately 5 kilometers southwest of the town of Katima Mulilo, along the B8 highway also known as the Trans-Caprivi Highway in the Liselo area. It takes a further distance of 2.5 kilometer off the main highway, a turnoff located opposite the Liselo Primary School northwards to reach the site.

The entire apportioned site measures eight (8) hectares. Figure 2 below provides an aerial view of the site.

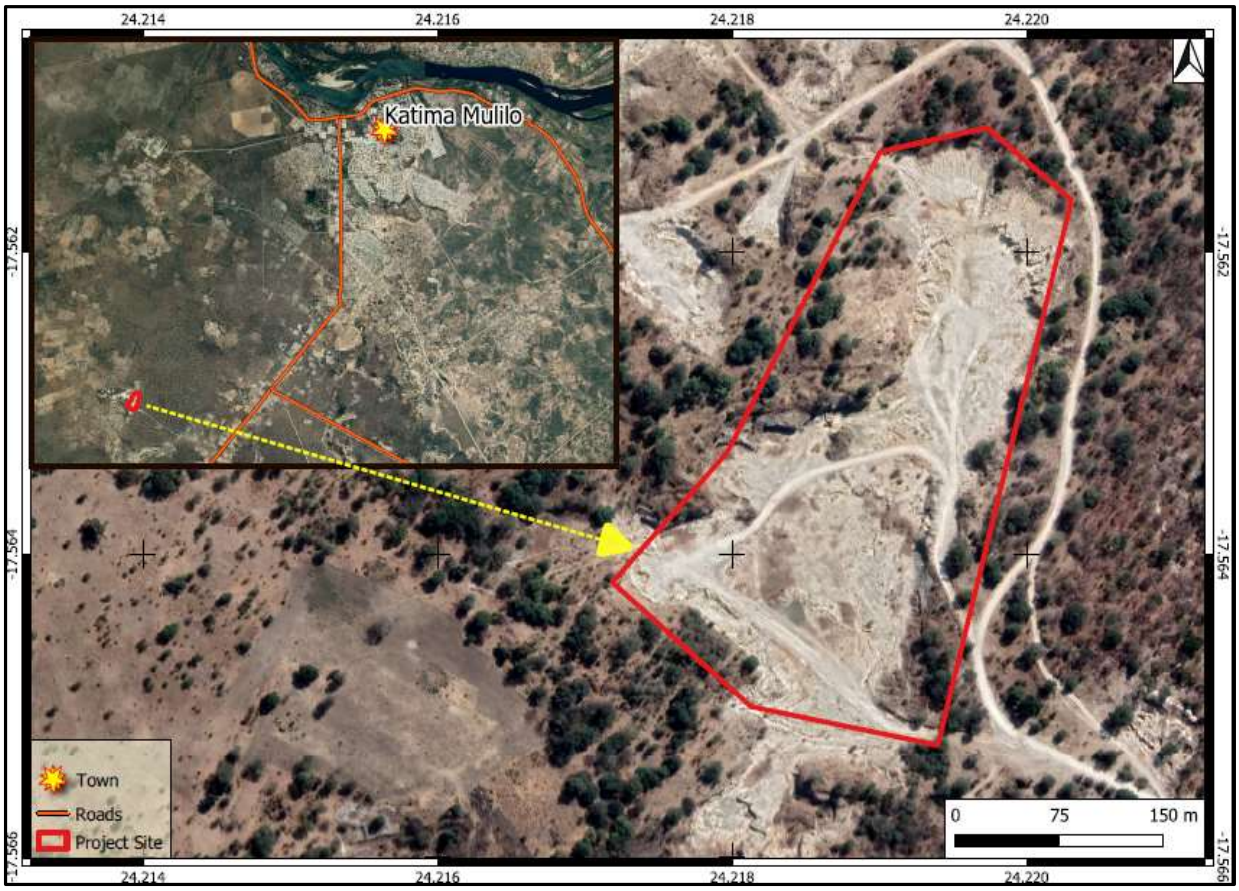

Figure 2 Location of project site

2.2 Background to the Site

Historically, the site served as a burrow pit for mining gravel material used extensively in the construction of gravel roads in the region. Due to the mining of gravel, the site is massively scarred. Active mining seems to have ceased many years ago, although signs of sporadic collection of gravel material at minute scale was observable to have persisted as the Proponent gained permission for temporal usage whilst fulfilling legislative requirements. There are no visible signs that there had been efforts towards rehabilitation of the excavated areas when gravel mining ceased, however, slow natural revegetation is observed in some most parts of the burrow, a sign of site inactiveness. Moreover, it was further not established if prior activities had been environmental cleared and thus possibility of existence of the rehabilitation plan for the site.

Figure 3 Ground outlook of the burrow pit

The burrow surface is approximately 8 meters below the general landscape surface. The westerns sides of the burrow comprise excavated walls at right angle to the burrow surface. Figure 3 provides a ground outlook of the site inside the burrow. The eastern sides of the burrow are lesser steep and therefore, elevation of the burrow surface decreases westwards thus site entry to the east.

The surrounding area specifically northwest of the site comprises other gravel burrow pits observed to be inactive and lesser signs of sporadic use.

There is a hand dug well inside the burrow, dug about 2m further into the burrow surface. This well was described by some local people in surroundings as mostly used for livestock drinking in drier times when water points comprising widespread pools are hard to find after the summer rains but also sporadic human consumption.

2.3 Land Ownership

Located outside the boundaries of the Proponent's townlands, the site is in the communal land of the Mafwe Traditional Authority (MTA), administered through the local sub-Khuta of Liselo.

In line with provisions of the Communal Land Reform Act (Act No. 5 of 2002), section 24, the Proponent should be in possession of an authorization for the apportioned piece of land from the respective Traditional Authority (TA). Moreover, such authorization is precursor to apply for recognition of a land right to the Land Board, and allows the board to consider the allocation by the TA and where satisfied ratify the decision.

The Proponent complies with the above section of the act as in form of an authorization letter by the MTA (Appendix D), to lodge an application with the Zambezi Regional Land Board (ZRLB) for recognition of the land right.

The above-referred Act further provides the process for appeals in Section 39, where any person aggrieved may appeal the decision of the TA accordingly.

Chapter 3

3. Description of Current and Future Activities

3.1 Current Waste Management Practices

This section sets out to review the administrative framework that sets out the waste management system implemented by the Proponent and further details and reviews the current waste current management practices associated. It is imperative that a detail description of the current operational paradigm is provided prior setting any new objectives and improvement to operations and utilization of the envisaged site.

3.1.1 Guiding Framework

A guiding framework is central to the nature of the operations and the extent of any such associated activities. Without such a framework, operations can become unsystematic leading operational inefficiencies and resultant wastage of resources. Moreover, such renders non-compliance to legislative requirements and thus may subject an entity to liabilities. An administrative guiding framework refers to the existing laws, policies, regulations, strategies and procedures that guides the current waste management operations.

The KMTC is governed by the Local Authorities' Act (No. 23 of 1992), with waste management stipulated under Section 30 of the Act on the powers, duties, and functions of Local Authority Councils. Under subsection 1(c), a local authority council has power;

> "…to provide, maintain and carry on services to such residents for the removal, destruction or disposal of night soil, rubbish, slop water, garden and stable litter, derelict vehicles, carcasses of dead animals and all other kinds of refuse or otherwise offensive or unhealthy matter".

The above legislative stipulation provides the overarching role and responsibilities for the Proponent; however, it is upon each council to put in place specific policies, regulations,

strategies and procedures that fit their context to guide and support effective waste management service in line with acceptable and required standard practice.

Secondly, the Public and Environmental Health Act, (No. 1 of 2015); under Part 9 of the Act and Sections 51 to 55 obligates a local authority to carry our functions related to waste management.

Further, to above overarching legislations, the KMTC has in place regulations relating to waste management in the Katima Mulilo town. These regulations are;

- Waste management regulations (No. 274 of 2004) of the Local Authorities Act. The entire regulations prescribe provisions and requirements for waste management in the town of Katima Mulilo.

- Street and Traffic regulations (No. 273 of 2004) of the Local Authorities Act. Section 8 of these regulations reiterates section 22 of the waste management regulations.

Moreover, in addition to the above, the proponent indicated that they endeavored to apply the waste management principles of the National Waste Management Strategy (NWMS) as guide to its waste management approach.

In relation to the overall administration of the waste management activities, these operations are under the Department of Community Services and Economic Development closely supervised and monitored by the Environmental and Health Officer (EHO).

The entire waste management process of the town is carried out through contractors.

3.1.2 Waste Management Operational Practices

Prior the acquisition of the new site and its temporal use, the proponent had previously operated two sites. The first site is located in proximity to the Zambezi Vocational Training Centre towards Katima farm. This site was utilized for many years prior closure in 2018 after being subjected to a compliance order and subsequently an instruction for closure after issues around its non-compliance were not resolved.

The second site is located behind the Puma Fuel Station, located along the B8 Highway to Kongola. The use of this site was a temporal measure after the closure of the first site in 2018; however, without finding a suitable site within the boundaries of the town, this led the prolonged utilization of the site. Operations to this site came to an abrupt end after another order for closure of the site was issued by the Office of the Environmental Commissioner due to issues associated with the site among such smog from open burning.

The steps or practices in waste management process for the Katima Mulilo town associated with the old dumping sites are described as follows;

3.1.2.1 Waste Disposal Practices at Source

Disposal of waste by residents (businesses, households and industry) regardless of types is into containers and at collection points (Figure 4). The only exception is for builder's rubble that residents are expected to dispose themselves to a Council designated site in line with waste management regulations (Section 13).

The are no measures in place requiring or providing any separation system for different types of waste although the waste management regulations has provisions to this effect.

Figure 4 Waste disposal at residences and businesses

3.1.2.2 Waste Removal/Collection

Waste contractors carryout the collection or emptying of containers from all areas of the town. Each waste contractor is allocated a location or section of a location they are responsible for collection and removal of waste. Collection of household waste is carried out once per week, whilst up to three or more times a week for the CBD subject to quantities of accumulated waste.

Since there are no practices or provision for waste separation, contractors apply no specific measures of handling different types of waste in the removal and loading process from various locations. All waste found at collection points is indiscriminately loaded into trucks.

The type of vehicles used for waste collection varies from one contractor to another; however, common are the open trucks as in Figure 5A. The average carrying capacity of these trucks is 6 tons. Only one contractor uses a compactor in removal of waste with capacity of 12 tons (Figure 5B). Each open truck can be estimated to attain loading capacity of 70 to 80%, prior heading off to the dumping site to offload. The 70 to 80 % loading capacity is premised on overall outlook of the trucks prior heading to the dumping site. This estimate is critical to establish as no weighing of waste is carried out due to unavailability of a weighing facility. The above loading capacity excludes the compactor truck that can carry much more volume of waste.

A

B

Figure 5 Type of vehicles used for waste removal

Unavailability of a weighing facility of loaded trucks limits any attempts to accurately determine the overall weight or volume of the waste material delivered to site daily.

3.1.2.3 Waste Transportation and Delivery at site

Waste trucks having attained fill capacity of 70-80% are sealed with netting prior transportation for delivery to the dumping site. The average truck makes up to four trips a day to the waste site, comprising a fleet of nine (9) vehicles. This therefore averages 36 trips made to the waste site per day for the entire fleet of waste trucks and over 5-days of the week upon which waste operations are carried out, this sums to 180 trips, and annually totals 9 360 trips.

As previously stated, lack of a weighing facility proves limitations to accurately quantify the amount of waste deposited per day and in such case, this can only be estimated based on the capacity of vehicles used in the collection and transportation of waste to the dumping site. Moreover, due to the different capacities of the truck, the average capacity established provides reasonable figures in the quantification process.

Given the average capacity of all the trucks (i.e. 6 tons) and actual loading estimated at 70-80 % fill capacity, this provides a daily tonnage range of 4.2 – 4.8 deposited at dumping site per loaded truck, thus translating to 37.8 - 43.2 tons per day for the entire fleet of nine vehicles. The weekly to yearly deposition is quantified at 189 - 216 tons, summing to 9 828 – 11 232 tons per annum.

3.1.2.4 Waste Handling and Treatment at Dumping Site

On arrival of waste trucks at dumping site, the content is deposited on existing waste heaps. Subsequent handling involves shifting waste together by use of a front loader to create more space for further deposition. Moreover, the front loader further compacts deposited waste to reduce their volume. This process is a continuous cycle.

Previously there had been pickers of recyclable waste at the old sites that collected and packaged to sell these to some local business for an income. However, these practices are described to have short-lived and eventually halted. Additional these scrap metal scavengers removed these materials from waste for sale to scrap collectors in the industrial area. The issue of open burning is strongly associated with searching of scrap metals and wires to the point that fires were set on tyres to expose content thereof for scavenging.

3.1.2.5 Types of Waste

The types of waste commonly handled and associated sources are summarized in the table below;

Area	**Type**
CBD	Plastics, cans, card boxes, bottles, and building rubble

Residential	Domestic waste, foodstuffs, plastics, tins, bottles, garden waste and building rubble.
Industrial area	Building rubble, metal
Medical waste	The proponent does not handle hazardous waste from the Katima Mulilo State Hospital. The Hospital has three main types of waste; the hazardous waste (red liners), food waste (green liners) and other waste (yellow liners) comprising bandages and classified as non-hazardous. The hospitals incineration facility treats red liners hazardous waste, while general waste in green liners and yellow liners are disposed of at general dumping sites of the proponent.

3.1.3 Limitations and Opportunities in the Current Waste Management System

A close examination of the entire process of waste management from the administrative framework to practices reveals as follows;

- Although the Proponents has indicated to have strived at aligning current practices with the NSWM Strategy, the entire waste management process does not apply any of the contemporary principles of waste management hierarchy in the current form and lack these attributes. This is an opportunity lost in that there are benefits that could be derived from aligning the waste management system along such principles.

- The guiding framework in form of legislation and regulations was found to provide a strong foundation upon which the proponent can implement an effective waste management system. Moreover, compliance and enforcement to certain waste management conduct is adequately addressed within the regulations. Such even provides to issue penalties and fines that enforces required conduct from residents. There is an opportunity that exists in utilizing the existing tools to achieve an effective waste management service to the town.

- Despite above supporting guiding framework, the Council lacks a strategy in place prescribing how to ensure an effective waste management system is implemented. The strategy will ensure that the proponent sets a desired vision, goals and objectives, translated into practical actions required to achieve a desired state over a sustained future. Such is an important tool for sustained operations into the future.

- Furthermore, the role of EHO oversees a broad area of responsibility inclusive of solid waste management to environmental health matters. The current setup could benefit from a role of an environmental officer or environmental compliance officer. Such a role can assist to ensure that in-depth environmental matters related to waste management are afforded necessary attention largely to ensure that implementation of the waste management system is enhanced. This role is recognized in the principal legislation and may become very necessary as the proponent aims to improve waste management service of the town.

- Lack of a waste record system. The implemented waste management system does not have at any point some sort of recording system in terms of information generated at various stages of the process. Without such a record system, it is difficult to determine and measure the effectiveness of operations, more so accurately plan for improvements, since at any point records need be generated from beginning.

The established shortcomings are consequence of the Proponent's aspiration to improve waste management for the town resultantly how to utilize the new acquired site in line with existing guiding principles nationally and beyond.

3.2 Objectives of New Waste Management Approach

The proponent has put forth as desirable in the new approach to the waste management practices the following;

- Practices such as recycling to form part of the waste management process
- Improving the handling and treatment of waste throughout the process chain

- Disposal of waste to be the last resort
- 'Landfill' concept preferable to the term 'dumping site', differentiated by application of different handling and treatment measures in the former and absent to the latter.
- Provide opportunities to communities in the waste handling process such as recycling

To be able to achieve the desired new waste management approach, the above aspirations align with the concept of integrated solid waste management (ISWM). The ISWM concept engrains strategic approach to sustainable management of solid wastes covering all sources and all aspects, including generation, segregation, transfer, sorting, treatment, recovery and disposal in an integrated manner, with an emphasis on maximizing resource use efficiency. The terms strategic and integrated are brought together through a waste management strategy, paving a clear path to achieving a systematic solid waste management system. Therefore, a waste management strategy is a necessity for the Proponent.

The NSWM Strategy as a guiding tool to local authorities aim to strengthen institutions capacities in solid waste management whilst guiding in improving practices through the principles therein. Such an approach provides opportunities in handling and treatment of waste to achieve efficiency but also minimize impact to the environment whilst harnessing socio- economic opportunities derived. The NSWM strategy outlines the waste management hierarchy as in the diagram shown below (Figure 6).

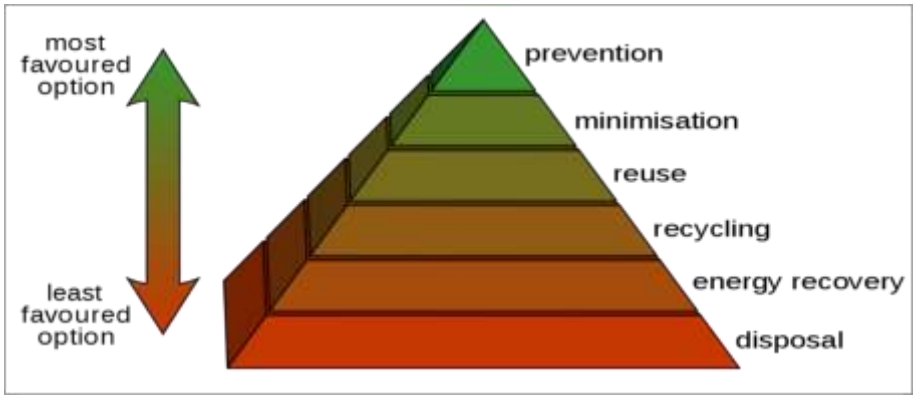

Figure 6 Waste management hierarchy

Table 2 Description of the waste management hierarchy

Measure	**Objective**	**Target stage**
Prevention and Reduction/minimization	To minimize the quantities of waste generated	At source
Re use and Recycling	To further reduce the quantity by prolonging the lifespan of an object/material by use in same or alternative form	Throughout the process
Recovery	Measures aimed at harnessing energy from the material	At the late stages of the process
Disposal	Dispose with high regard for safety of the environment, people and economics	Least favorable but unavoidable stage

To attain an integrated waste management approach through the referred waste management strategy, the following are pre-requisites;

- The highest level of commitment from higher structures of the Council towards implementing an effective integrated solid waste management system.
- Allocation of adequate resources in funds and human resources towards implementation of the desired approach.
- Commitment towards programs intended for training, awareness and participation of staff and residents towards the implementation of an effective waste management approach.

Bearing above aspirations, the activities elaborated in further sections are envisaged towards establishment and operation of a landfill at the acquired site engraining the principles of integrated solid waste management.

3.3 Future Operational Configuration

The establishment of a landfill site and its operation to service the Katima Mulilo town will involve a series of activities in the various phases of the process from preconstruction, construction to operation. The site does not provide for operational infinity; thus, it is necessary that decommissioning of the site be also planned from onset as per requirements of environmental legislation. Therefore, the following activities are envisaged in sequential phases of the process to establish a waste management facility in line with required processes;

Table 3: Activities envisaged for the Site at different phases

Phase	**Envisaged activity**
Pre-Construction Phase (Site preparation)	○ *Site planning* ○ *Site demarcation and marking off areas*
Construction phase	○ *Construction of boundary fence* ○ *Site earthworks* ○ *Construction of support facilities, waste handling and treatment facilities*
Operation Phase	○ *Waste disposal at source* ○ *Waste collection/removal at source* ○ *Transportation of waste to the landfill site* ○ *Offloading, handling and treatment of waste at landfill site* ○ *Maintenance of support structures*
Decommission Phase	○ *Stakeholder engagement* ○ *Demolishment of redundant structures* ○ *Cleaning and landscaping of the area* ○ *Closure/site aftercare*

The above-envisaged activities are described in the detail in subsequent section.

3.3.1 Landfill Classification system

3.3.1.1 Standards/requirements for landfill sites

There are no prescriptive standards or requirements for landfill sites in Namibia, however, this in no ways infers that standards are not applicable to construction of landfill sites. Different projects have applied diverse standards to establishment of landfill sites; however, the use of standards or requirements from neighboring South Africa remains acceptable as among best practices in classifying and meeting design requirements for different landfill sites in Namibia. This report therefore applies the MR2 requirements for this assessment. These requirements characterize a landfill site based on three important parameters;

- The class or type of waste handled
- Size of the waste volumes or stream received per day
- Potential generation of leachate

3.3.1.2 Classification of the Envisaged Liselo Landfill site

The envisaged Liselo landfill site can be classified as follows;

- **Class of Waste**

The main waste types handled and treated by the Proponent is mainly general waste. Handling of any high order waste (i.e. hazardous) is restricted to ash and its residuals that require mainly burying at a specific demarcated area. The site therefore, is classified as General Waste landfill site (i.e. G).

- **Size of the waste**

Landfills are characterized on size based on amount of waste received per day and thus records and that enable quantification of waste deposited at the landfill site are critical. Different methods are recommended for application where no weighting of waste is implemented. Such includes totaling the number of cars and determine volume to tonnage deposited.

The Maximum Rate of Deposition (MRD) for the site is calculated in the range of 61.99 to 70.85 tons per day. This indicates that the size of the landfill site can be characterized as a small landfill site (i.e. S).

- **Potential Generation of Leachate**

It is critical to determine if a site requires a leachate management system from pre-set. This allows for adequate planning and design of a leachate management system. Despite this aspect requiring consideration of the most wet and dry years' climatic data, the climate of the region and much of the country is characterized as moisture deficit. The Zambezi region itself has evaporation rate in the order of 2400mm per annum relative to rainfall of 700mm per annum thus affirmation of prevailing moisture deficit. Based on this relationship, the site is characterized as sporadic leachate generation landfill site (B^-), thus a leachate management system is not required but prescriptive base design is obligatory to contain any sporadic leaching.

3.3.1.3 Earthwork Design Requirements

The envisaged Liselo landfill site is classified as a G, S, B^- landfill site. The design requirements for the referred landfill site is provided in Figure 7.

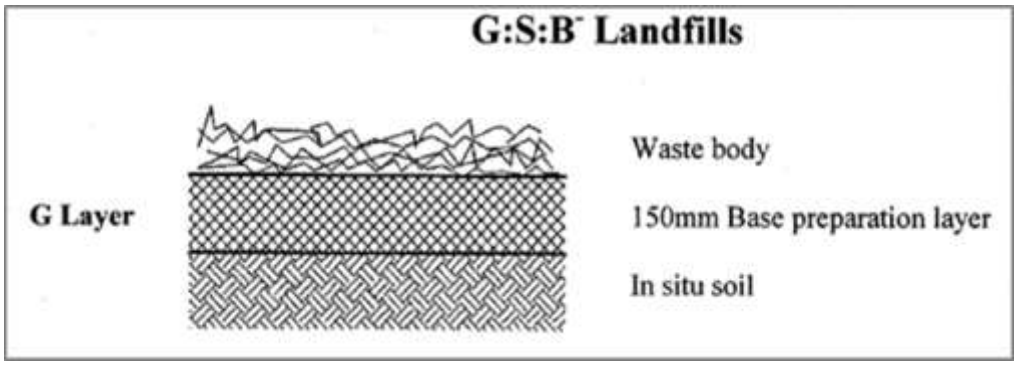

Figure 7 General waste cell base layering design requirements

3.3.2 Pre-Construction Phase Activities

3.3.2.1 Site planning

To align all subsequent activities to utilize the new site along principles of integrated solid waste management, implementing best practices, it is critical that the first step is provide for handling and treating different types of waste distinctly. To this effect, the site requires to provide for clear separation of areas to allow differentiated handling and treatment of waste. The following areas are provided for in the site layout; garden refuse waste cell/area, building rubble waste area, sorting and packing area for recyclables, incineration facility area, evaporation pond (storm water holding area), hazardous residual waste cell or area.

Further to the above handling and treatment areas, office and other facilities to support onsite operations are necessary provisions.

The diagram below (Figure 8) provides an outlook of the site utilization layout providing for different facilities as required.

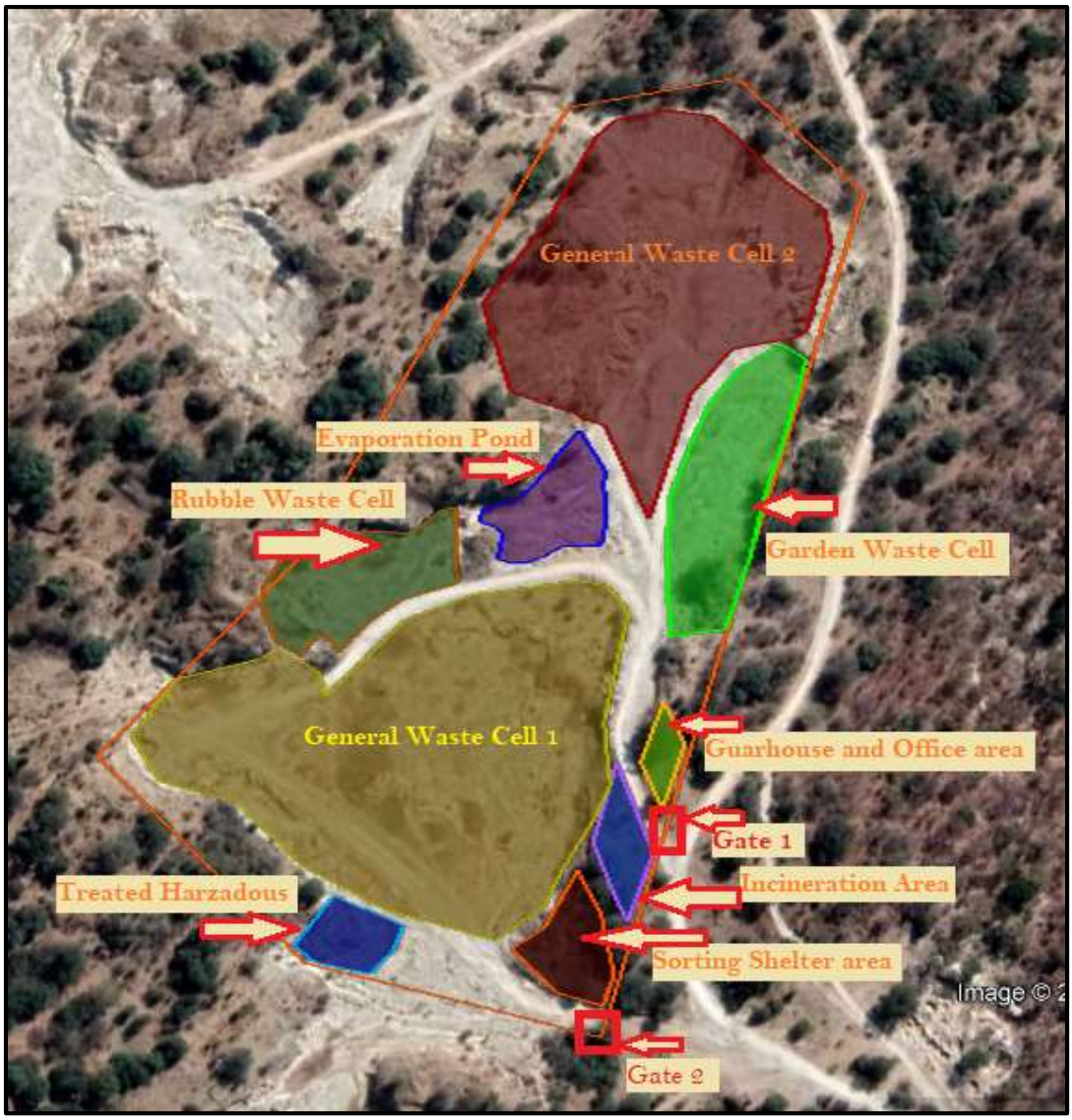

Figure 8 Site layout plan

The allocation for each of the required area is as follows;

Table 4 Site area allocation to different onsite facilities

Allocations	**Area (ha)**
General waste cell 1 (C1)	2.3
General waste cell 2 (C2)	1.7
Building rubble area	0.33
Garden refuse area	0.5

Incineration area	0.1
Sorting and packaging area	0.15
Evaporation or storm catchment pond area	0.2
Hazardous residual area	0.11

3.3.2.2 Demarcation and Marking off Areas

The site layout plan as provided requires appropriate delineation, marking off and signage placement accordingly to ensure that all subsequent activities in the later phases are restricted to their specific areas.

3.3.3 Construction Phase Activities

The construction phase will involve the following activities;

3.3.3.1 Construction of the fence

Controlling access to a landfill site is one of the highest priorities in their management, thus this requirement is an absolute necessity. This is further necessitated that the proponent was issued temporal usage of the site and thus it is critical to manage temporal activities ongoing at the site. While the Proponent envisages constructing the fence (Annexure G) to restrict activities within but also control outside access to the site. the site is presently guarded by securities as preliminary. However, the construction process will involve perimeter clearance of the fence will be marked cleared of any obstacles. The envisaged type of fence requires minimal excavation of the ground perimeter for the foundation. All materials for fencing will be acquired from town, transported, and stored onsite as project progresses.

3.3.3.2 Site earthworks

The nature of the burrow surface is uneven from previous activities and thus requires leveling and compacting. The required design of the general waste cell is provided in Figure 7. The requirements specify a base layer comprising mainly clay (G) compacted over *in-situ* layer of soils, attaining a minimum thickness of 150mm. Such clays are widespread within the burrow area, being a previous gravel-mining site.

3.3.3.3 Construction of Support Structures and Waste Facilities

The following structures are necessary for establishing landfill sites;

- **Access Road**

  The site is presently easily accessible as there is a gravel road to the site; therefore, not a necessity for construction of an access road.

- **Security Guardhouse and Site office**

  A well-managed waste management facility requires access control at all times, therefore, construction of a security guardhouse is critical to controlling site access. Further to the guardhouse is an administration office, where site administration activities are housed. The construction of ablution facilities will utilize septic tanks as holding systems for resultant effluent. The design will not allow trickling of effluent into the adjacent soils but contain effluent with provision for pumping at scheduled times. The pumped effluent will be transported to the wastewater handling facilities of Katima Mulilo town for adequate management. The design of a septic tank is given in Annexure J.

- **Water Supply**

  The water supply infrastructure (pipeline) in the area is located along the B8 highway a substantial distance from the site. A connection to this pipeline will not be pursued; however, alternative water supply option involving setting up of water tank facilities and regular ferrying of water from town is envisaged. The number of people at site is envisaged to a maximum of 10 persons at one time in the various operations of the site. At an average estimated water demand of 70 liters per person per day, a 10 000l tank will be serviced biweekly.

- **Electricity Supply**

  There is no nearby power supply infrastructure to the site with the distance to the nearest infrastructure of NORED a distance of 2.5km. A connection to this infrastructure is not envisaged thus alternative sources are planned in a solar voltaic

system, utilizing alternative energy sources and alleviating energy demand on national infrastructures.

- **Waste Sorting Facility**

In many African urban centers, there is limited setup of highly sophisticated automated recycling plants due to investment costs involved, more so where electricity supply is also a major limitation. However, this does not preempt setting up of facilities or operations based on alternative innovative methods.

The aim of recycling is to reduce volumes of waste destined for landfilling. Such is also attainable through techniques of reclaiming waste for purposes of reuse. The purpose of an onsite facility is to house activities relating to waste reuse and recycling (Figure 9). The facility will receive differentiated reusable and recyclable materials from town, but also receive that picked from the waste cells onsite. These will be sorted where necessary into types and package separately for further handling or treatment. Reusable material also requires being separated and placed in allocated area to allow opportunities for retaining of such material.

A manual sorting and processing station is more cost-effective for the site. This will require a number of waste pickers and sorters to continually reclaim target materials from waste delivered to site. Targeted waste comprise plastics bottles, cans, glass bottles, cartons, plastic packaging and metals mainly on the general cell.

Figure 9 Illustration of an envisaged sorting shelter

Other reclaimed material will be destined for incineration such as unusable cartons boxes, plastic packaging and papers.

- **Garden Waste area**

Composting of waste requires a carefully designed process from source to landfill site. Moreover, the conditions required to attain the process of composting are demanding to put in place for many landfill sites, moreover, maintenance of this process requiring significant dedication. Such facilities become dormant not very far from being setup. Due to this, composting is not envisaged attainable at the site; however, this does not eliminate the opportunity to separate garden waste and treat distinctly.

Separation of garden waste enables optimize the use of the site, in that the volume of garden waste reduces over time due to their compressibility. Moreover, this can be attained through handling of some waste specifically large stems and branches by acquisition of a wood chipper machine to produce wood chips with additional functionality of shredding leaves, a substantial component of residential waste several months of the year (Figure 10). If further well-handled and packaged, wood chips and shredded leaves are usable in sustainable agriculture for mulching processes. This presents an opportunity for a small-scale operation to supply mulching material where needed in the region. It is therefore a necessity for the area marked out to handle this waste. This will help achieve reduced volumes of waste and prolong the site lifespan to serve the town. The marked area needs less intervention except landscaping of the area to attain level surface.

Figure 10 Wood chipper and leaves shredder machine

- **Incineration Facility**

Open burning is problematic due to widespread smoke generated and risk of fires spreading beyond controllable areas. While the distance to the nearest permanent village is reasonable at 1.5km towards the highway, open burning of waste is not envisaged because the resultant smoke travels more distances with prevailing winds and thus becomes a nuisance to communities. However, burning of waste is a reasonable and acceptable waste treatment technique in reducing the volumes of waste at landfill sites but also in treating risky substances that may be contained within disposed material at landfill sites. Incinerators typically reduce the weight of the waste by up to 85% and their volume by up to 95% depending on the composition of the original waste, therefore a useful technique. However, its application requires better control to ensure that resultant smoke does not cause a constant nuisance. Incineration unit provides a most acceptable way to continually utilize this method for its benefits.

A permanent incineration facility although expected to be valuable to the proponent as the town develops, is not envisaged. A facility of high standard with substantial investment is more feasible when located within town boundaries (i.e. industrial area) and resultant treated waste safely disposed at the landfill site.

To utilize incineration method at the current site, a simplified basic prefabricated or brick made unit is envisaged that can be constructed from vocational skills within the region (Figure 11). The essence is to prevent open burning of waste, but safely implement this method in prolonging the site lifespan. Target material for incineration include card boxes, papers, large plastics packagings. Incineration activities are planned only on certain days of the week dependent on amount of waste isolated. Moreover, the days shall be spaced to ensure that no constant smoke is continually retained in the atmosphere but also that the amount released are minimal for a short duration.

Figure 11 Illustration of prefabricated incinerator unit

- **Construction of storm water facility**

Due to excavated nature of the site, it is envisaged that during rainfall period, water will flow from adjacent elevated burrow surfaces and therefore a necessity that a holding area is established, without it the accumulated flows may become problematic. This area will require minimal excavation to depth of 1.2m towards the western walls of the burrow (Figure 14). The entire area inclusive of the point where a hand dug well exists will form part of the pond area. This area is minimally excavated at present below the general burrow surface and only needs further shaping embankments and leveling of the surface.

The prepared surface will be compacted and covered with HDPE liners (Figure 12 and 13). The collected water is envisaged for the purpose of evaporation, but also use in drier times for dust suppression. Flows from outside the fence will be diverted away from the site due to the above ground foundation of the fence and thus reduce erosion from adjacent areas into the burrow.

Figure 12 Conceptual water flows inside the burrow based on surface terrain

Figure 13 Illustration of a lined HDPE pond

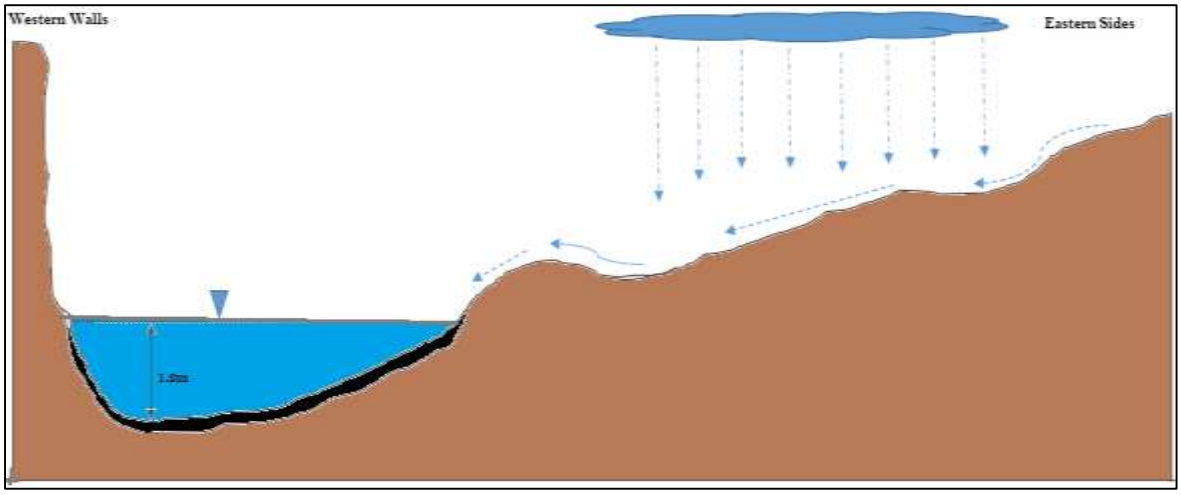

Figure 14 Conceptual evaporation/storm water pond

- **Construction of weighbridge**

Records of waste volumes generated are critical for improved handling and treatment of waste. Therefore, a weighbridge is envisaged for construction at the main entrance gate. A platform of concrete surface will be constructed for the placement of a mobile weighbridge. All vehicles carrying waste to the site will be required to pass over the bridge for recording of waste information.

- **Medical residue disposal area**

Handling of medical waste is envisaged to be restricted to ready treated material from the State Hospital's incineration unit, comprising mainly ash and associated residues. This will be handled in the area marked for disposal of this waste on the site plan. The disposal area will have compacted base, and own internal fencing for controlled access.

3.3.4 Operational Phase Activities

3.3.4.1 Waste disposal at source

Disposal of the waste at source determines handling opportunities further downstream of the waste management process. The aim at this stage is to implement contemporary waste practices at source, integrating the 'most preferable' methods in the waste management hierarchy. The overall aim at this stage of the process is to prevent and

minimize or reduce waste at earliest. Reducing waste generation as the more practical can be achieved through provisions for waste separation and early recycling and reuse opportunities. Residents are to be provided with separate waste disposal ways to initiate waste separation practices.

Figure 15 provides an illustration of waste separation provision in public spaces. Containers as illustrated are easily accessible and a cost-effective way to provide for waste separation around public spaces inclusive in CBD, schools and general open spaces in residential areas. Moreover, these will be complemented by devising an awareness program to residents of the required approach to encourage and trigger such practices. These will target schools, public fora such as radio; inducing aspect of prevention of waste to the public, attainable only through sensitization.

Figure 15 Illustration of waste separation provision at public spaces around town

Waste container liners are a requirement in the waste management regulations, however mainly for certain waste such as that which may cause odour, smell or injury. A pilot of one location to provide liners for separating of waste will be explored to determine sustainability. The use of liners will target separating recyclable waste from general waste at residences and businesses premises.

One of the problematic waste is large quantities of food waste from food outlets and that, which may have expired from retail shops. In its large volumes beyond Council provided containers, the owner of the waste will be required to transports this waste to the landfill site for further handling, however, additional measures will be considered in

line with additional efforts exerted by such waste. The proponent will develop procedures to prescribe such and afford necessary measures in handling.

Moreover, material such as metals and card boxes are better handled when placed in an organized manner in case of residences or in own cages in case of CBD where large quantities are generated (Figure 16).

Figure 16 Well managed waste placement in preparation for removal

Building rubble and garden waste are one of the most significant waste generated in developing towns. A reasonable quantity of this type of waste can be well handled with provision of waste skips of the form in Figure 17. To maintain hygienic and aesthetics around town, certain points will be identified in suburbs for placement of skips to provide for disposal of rubble and garden waste separately. The proponent aims to provide two skips marked out accordingly for garden and building rubble waste.

Figure 17 Waste skip provision for garden and building rubble

Rubble waste from big construction activities remains the responsibility of residents that will be required to self-transport this waste and dispose accordingly at landfill site and where possible and necessary handling fees for additional quantities beyond specified established and charged.

3.3.4.2 Collection of waste at source

Collection of waste by contractors will remain as current practice of loading into open trucks. The average trucks utilize manual loading of waste; thus, contractors have control over loading different types of waste into the trucks according to the criteria for offloading at landfill site.

In future, the number of compactor trucks is likely to increase and foreseen to play a greater role in waste removal. This will align with current efforts to improve disposal of waste at source through provision of improved waste containers to residents (Figure 18).

While such are a significant improvement in rendering waste collection services, the increased compactor trucks will necessitate dedicating smaller trucks to operate in removal of differentiated waste at source more specifically reusable and recyclables, as compactors vehicles lend this challenging to achieve. This will increase capacity to provide opportunities for reuse and recycling of materials.

Figure 18 Proponents new waste containers rollout initiative

The removal and collection of certain waste such as rubble and garden waste skips will require appropriate lifting trucks; these are separate from the general waste contractors truck currently utilized (Figure 19).

Figure 19 Illustration of Waste trucks specialized for waste skips

3.3.4.3 Transportation of Waste to Landfill Site

Current practices ensure that waste is secure on trucks during the transportation process to the waste site to ensure that no material flies off the trucks into the adjacent surroundings. This practice is to be maintained to align with operational protocols envisaged for the new site.

3.3.4.4 Weighing, Offloading, Handling and Treatment of Waste at Landfill Site

It is important that a weighbridge facility be erected on entrance at the site required in implementing an effective waste management system. Once arriving waste trucks are weighed and necessary information recorded, the vehicle proceeds to the demarcated waste cell for the category of waste carried to offload. Pre-separated recyclable materials collected from provided separation points will be delivered at the sorting shelter area for further handling required.

3.3.4.5 Picking, Sorting and Packaging of Reusable and Recyclable Waste

Upon deposition of undifferentiated waste specifically onto the general waste cell 1(GC1) and subsequent years' general cell2 (GC2), the waste pickers will isolate and

remove recyclables and reusable materials therefrom. The targeted recyclables are tins, plastic and glass bottles, cans, card boxes, papers, cartons, and metals. All material removed will be sorted accordingly, packaged and stored in the sorting shelter and around awaiting collection by waste recyclers (Figure 20). The Proponent will engage various businesses locally and beyond the region with interest in recyclables for cooperation in established opportunity.

Figure 20 Illustration of sorting and packaging of waste at sorting shelter

3.3.4.6 Incineration

Incinerated waste will comprise unusable card boxes, cartons, paper, and some plastic packaging. Incineration will only be carried out as planned in a prefabricated unit or built unit and as per scheduling to be developed. The final ash from the incineration will be disposed on the general waste cell.

3.3.4.7 Compacting and Covering General Waste Cell

Besides picking of recyclables, the mainstream remnant residual waste be shifting together in line with the envisaged landfilling approach, compacted and covered with sand clay material. A specialized compacting machine is not envisaged for acquisition in the immediate, thus utilization of similar purposed machines such as a front loader up to a time when a compactor machine can be available locally for use at site is envisaged. The covering clay material will be excavated from the GC2 for the GC1 in the initial utilization of the site. An infilling approach referred as the cell method (Figure 21) is the envisaged to landfilling.

Figure 21 General waste cell landfilling approach

Utilization of GC2 will require the proponent to make necessary arrangement for additional cover material from elsewhere and this is considered a specific activity on its own and not included in this report.

3.3.4.8 Road Maintenance

The existing access road to the site will require constant maintenance due to frequent use by waste contractors. Such will involve occasional grading of the surface for smoothing and compacting.

3.3.4.9 Wastewater treatment and disposal

The wastewater from the ablution facilities will be captured in constructed septic tanks. A schedule for emptying effluent from the tanks will be established, that will outline the transportation the effluent to the towns wastewater plant for suitable handling and disposal.

3.3.5 Decommission Phase

The extent of decommissioning activities required for a site is dependent on after use of the land and such is subject to a process of consultations and agreement with the stakeholders as to suiting uses of the land post its lifespan. Therefore, throughout the lifespan of the site, consultations are expected between the Proponent and the stakeholders including the local community, regional authorities and traditional authorities on possible future uses of the site, taking cognizance of the adjacent land uses

Such shall establish an agreeable future use of the site to allow the proponent to align closure activities accordingly.

The surrounding land right application indicates mostly crop fields and some limited residences. The end use of the area is to be consider these adjacent land use activities, however uses such as residence or those requiring stable grounds are not envisaged for the site but others such as a forest plantation can be considered more practical once the landscape is well prepared.

In light of the above, it is expected that the following activities will form part of the site decommissioning, unless so altered after consultations with stakeholders and agreement thereof.

3.3.5.1 Demolishment of Structures

Removal of any unusable structures erected onsite is the first step to clearing of the area in preparation for closure; the sorting shelter, incineration unit, and other infrastructures that may be needed elsewhere will be removed from the site and surface where located loosened. Other infrastructure such as the fence, guardhouse and office may remain however subject to the agreement on after use plan.

3.3.5.2 Cleaning and Landscaping of the Area

Once dormant structures and materials are removed from site, the site will be cleaned of any residuals that may be of aesthetic impediment and subsequently landscaped to mimic adjacent landscape.

3.3.5.3 Transportation of residual material to town or new site

Any remaining useable properties of the proponent will be transported off site to town or new site for further use or storage.

3.3.5.4 Closure and aftercare

The site will be closed entailing minimal activities taking place, as operations would relocate to the new site where such is established. The waste cell design for this type of site is unlined as per the MR2 requirements, therefore there remains potential that the landfilled material may still generate leachate beyond the site's lifespan and thus need for continued care of the site. Therefore, aftercare measures are required for the site.

3.4 Site Lifespan

The lifespan of the site is critical to determine to provide a guide on the availability of the site to the proponent for utilization. However, although estimated based on the current practices, the lifespan of the site is reliant on the implementation of the envisaged improved waste management practices. Should such practices remain as previous norm, the lifespan can drastically reduce.

It is important to determine the open space of the site or the void to be utilized to determine the longevity it can serve relative to the initial rate of deposition (IRD) also taking into consideration the population growth. The volume of the void was estimated at 640 000m^3. Using the MR2 methods in estimating the lifespan of the site based on initial rate of deposition (IRD) of the range of 37.2 – 43.2 ton per day at growth rate of 1.3% for the region, the lifespan of the site is estimated 30 years from the first year of operation premised on previous operational configuration. However, should the volume of the waste reduce due to envisaged operational practices, by least 20%, the IRD will be at 30.24 - 34.56 tons per day and this adds 7-9 years to lifespan of the site, thus close to 40 years of operations.

It is therefore important that implementation of the envisaged waste management system is prioritized if the site is to serve the proponent for the longest foreseeable future.

3.5 Need and Desirability of the Project

The need for the establishment of the waste facility is obvious and self-evident. Since the closure of the last dumping site, the after effects led an undesirable state in the town of Katima Mulilo. To the present, remnants of resultant random disposal of waste on the outskirts of the

suburbs are evident. The lack of a site for waste management almost compromised the health and safety of residents, with potential to spread beyond town boundaries to adjacent communities in communal land area.

The Proponent is compelled by presiding legislation to provide a healthy and safe urban environment to its residents but also uncompromising to the towns adjacent communities. To be able to deliver an effective service, it is indispensable that an area is apportioned within the local authority to management of the towns waste, however, where no suiting sites are available within, a local authority may request and where allocated establish a waste site outside their boundaries. Therefore, establishing a waste management facility is an obligation than mere option for the Proponent.

3.6 Project Alternatives

It is imperative in line with environmental legislation that alternatives to the tabled option for waste management are considered, arising opportunities and adverse effects evaluated. The following are considered in terms of alternatives and their applicability relative to the current option evaluated. The alternatives are;

- Alternative site
- Alternative activity
- No go alternative
- Go ahead alternative

3.6.1 Alternative Site

Prior acquisition of the current site, the proponent devoted enormous efforts to apportioning a site for the facility inside the townlands; however, this was not achievable due to the limited extent of the town. Moreover, where potential for a site exists, this is in proximity to settlements and thus undesirable. Therefore, there is limited suiting alternative sites. In relation to the present site, the following are pros and cons are considerable;

Advantages

- The present site is a brownfield, while any other would potentially be a greenfield
- The area is reasonably away from permanent settlements of the town and that of communities of the local area.
- The site comprises clay material important in covering landfilled waste but also an advantage in layering the base of the cells for protection of subsurface resources.
- The site is remotely located thus hidden from sight to be an eyesore or a constant nuisance.
- The establishment of the facility there provides opportunities for local communities to benefit from utilization of a derelict site.
- The site does not have a rehabilitation plan and thus the current activity can be some effort towards restoration of the site to recover its natural form.

Disadvantages

- The previous excavation reduced the depth of the unsaturated zone, presenting a potential risk to subsurface resources.
- The distance from town to the landfill site comes at a cost to the proponent in daily transportation of waste.
- Pollution of the landscape by littering, smoke or some disturbances to the adjacent area and nearby communities are possible in the utilization of the site.

3.6.2 Alternative Activity

The desire of the proponent is to operate a landfill site than a mere dumping site. A dumping site approach has the final stage at dumping waste; however, the landfill approach involves a designed process that mitigates the potential impacts of the activity on surroundings landscape, communities and their associated values, and natural resources. Therefore, the current activity is the best approach to waste management by a local authority and aligns with contemporary practice in higher classed local authorities in the country.

Advantages

- The planned approach of a landfill addresses common problems of waste sites such as odour, smoke, pollution and other on surrounding landscape.
- The planned approach aligns with the National Solid Waste Management Strategy.
- The envisaged approach optimizes utilization of the site into the future reducing frequent need for new sites.

Disadvantages

- There remains risk of not managing all negative consequences that come with the activity.
- Financial resources may not be available to implement all planned activities thus deviation from desired operational state.

3.6.3 No-Go Alternative

The no-go option would entail that the Katima Mulilo remains without a Waste Management Site for the near future. This ideally means that the proponent would not improve its services for the town of Katima Mulilo, thereby not improving service delivery and also losing the opportunity of reducing pollution, creating much needed direct and indirect job opportunities whilst face the prospect of unhygienic conditions in and around the town.

Advantages

- Any potential pollution of the landscape, groundwater or air will not will not occur at all.
- No disturbance to the soil in the adjacent landscape will occur.

Disadvantages

- The site remains in its scarred unusable state without any plans for rehabilitation of some sort.

- The proponent remains without a waste management site, prolonging the time to find another alternative site and carry out subsequent land acquisition process, legislation compliance requirements to operate the site.
- Any opportunities for jobs for the local community and other support from the proponent are not realized.

3.6.4 Go-ahead alternative

The go-ahead alternative presents the most feasible alternative in that it entails that the proponent can implement the envisaged new approach to waste management to the entire waste management process. This will improve service delivery in the town and this has benefits to the town and community where the site is located, despite some negative outcomes that potentially arise from implementing the activity.

Advantages

- The proponent delivers improved and effective waste management service for the town of Katima Mulilo.
- Any socio-economic benefits resulting from site utilization are realized for the region and community of the area
- Reducing pollution of the environment.
- Implement waste management system with highest purpose to prevent environmental impacts and safeguard human health and safety.
- This activity forms some effort towards rehabilitation for the scarred site.

Disadvantages

- Potential of pollution to the environment (water, landscape and air)
- Disturbance of soils
- Health risks to the workers in waste management process
- Some adverse effects to the adjacent communities

3.6.5 Decision on Alternatives

The provided alternatives are evaluated as follows;

Alternatives	**Decision**
Alternative site	Preliminary use of the current acquired site is an indication of the constraints to find a suitable alternative site by the proponent and thus the acquired site remains the most feasible.
Alternative activity	There are no alternatives to waste management, despite improvement to the entire process, the remains need for a site to manage residual waste.
No go alternative	This alternative is undesirable, as it has been tested prior, when the proponent had no site to store waste temporarily. Resultant was the outskirts of the town becoming dumping areas and growing unhygienic conditions that had potential to become catastrophic.
Go ahead alternative	The alternative remains the most feasible of the above considered due to many benefits it holds environmentally and associated socio-economic opportunities should resultant negative impacts be found manageable.

Chapter 4

4. Review of Legal Framework

The following legislative instruments have been considered of relevance to the activity and their applicability evaluated.

Legislative Instrument	**Requirement**	**Applicability**
Namibian Constitution (1990)	Article 95 on maintenance of ecosystems, essential ecological processes and biological diversity of Namibia and utilization of living natural resources in a sustainable way for the benefit of all Namibians, both present and future.	A relatively high level of environmental protection is called for in respect of pollution control and waste management and protection of natural resources
Environmental Management Act No. 7 Of 2007 And Environmental Impact Assessment Regulations GN of 2012 and	Aims to promote the sustainable management of the environment and the use of natural resources. Further provides for a process of assessment and control of activities that may have significant effects on the environment. The Act and its regulations prescribes the requirements for obtaining an ECC for listed activities.	As listed activity, this project is to align with the requirements to conduct an EIA process and the application for ECC, and important to the process is the prescription on the public consultation process.
Environmental Assessment Policy	Prescribes the steps in the environmental impact assessment process.	The process of EIA to align in accordance with the prescribes steps
Water Act No. 54 Of 1956 (The Water Resources Management Act No 11 of 2013)	Institutions responsible for an activity with potential for pollution to take necessary steps to prevent occurrence. Handling and treatment of effluent requires a permit.	Take all necessary efforts to prevent the pollution of groundwater Should facilities envisaged plan to handle and treat effluent, a permit will be required.

Labour Act Of 2007	The objectives of the Act are to ensure the health, safety and welfare of employees but also outlines the rights and obligation of employers.	The health and safety of workers throughout the waste management chain need to be assured.
The National Heritage Act (No. 24 Of 2004)	Prohibition is placed on removing or demolish, destroy or despoil, develop or excavate all or part of a protected place. Such can be only conducted under provisions of an exemption or under a permit issued by the council. Moreover, should during operations an object of historical significance be uncovered, the operations are to be halted immediately.	Should a heritage site or archaeological site (e.g. a grave or stone markings) be uncovered or discovered during operations, the prescribed procedures need be adhered to.
Soil Conservation Act 76 of 1969	Intends to combat and prevent soil erosion, and for the conservation, protection and improvement of the soil, vegetation and the sources and resources of the water supplies. Under section, 4 the Minister may by means of a direction order the owner of land to construct the soil conservation works.	Ensure project designs consider soil stability to prevent erosion processes.
Atmospheric Pollution Prevention Ordinance 11 of 1976	To provide for the prevention of the pollution of the atmosphere. The act sets to ensure activities that produce fumes, dust or smoke take necessary measures to control such activities to minimal levels.	Although the act relates mostly to emissions of dust and noxious gases in prescribed areas, necessary measures need be taken to ensure release of noxious gases and dust is minimized in proximity to human settlement areas and prevent pollution.
Hazardous Substances Ordinance 14 of 1974	To provide for the control of substances which may cause injury or ill-health to or death of human beings by reason of their toxic, corrosive, irritant, strongly sensitizing or flammable nature or the generation of	Sets restrictions on import, storage and sale of certain groups of hazardous substances without a permit for overall human safety and health.

	pressure thereby in certain circumstances. Further provides for the prohibition and control of the importation, manufacture, sale, use, operation, application, modification, disposal or dumping of such substances.	
Public and Environmental Health Act (No.1 Of 2015)	Provides a framework for a structured uniform public and environmental health system in Namibia	All waste disposal, sanitation, supply of foods by commercial entities must be in accordance requirements of the act. More, so the act provides for the local authority to carry out the activities of waste collection, and disposal including recycling and operating a waste site.
National Solid Waste Management Strategy	The strategy aims to strengthen institutional and legal framework for management of solid waste serving as a guide to institutions such as local authorities on sound waste management practices.	Consider the principles of waste management in setting up measures for management of solid waste.
Nature Conservation Ordinance (No. 4 Of 1975) and It Amendment Act of 1996	List wildlife species under protection and activities allowed and not allowed when in area with wildlife.	Where wild animals exist in the area, the requirements of the act to be adhered relating to handling such wildlife.
Forest Act of 2001	The act aims to provide for the protection of the environment and the control and management of forests.	Where protected species are found in the area, extensive clearance of the species requires a permit from the regulatory authority.

Pollution Control and Waste Management Bill	This Bill will serve to regulate and prevent the discharge of pollutants to air and water as well as providing for general waste management. This Bill will license discharge into watercourses and emissions into the air. The Bill also provides for noise, dust or odour control that may be considered a nuisance.	Proactively consider the implications of the requirements on the envisaged activity and align accordingly.
The Local Authorities' Act (Act No. 23 of 1992)	define the powers, duties and functions of local authority councils	Section 30 1(c); empowers a local authority to provide, maintain and carry on services to such residents for the removal, destruction or disposal of night soil, rubbish, slop water, garden and stable litter, derelict vehicles, carcasses of dead animals and all other kinds of refuse or otherwise offensive or unhealthy matter".
Convection on Biological Diversity (CBD)	Namibia is obliged under international law to conserve its biodiversity.	Projects should consider actions where the envisaged activity may cause damage to biodiversity.
Communal land reform act (Act no 5 of 2002)	Provides for the allocation of rights in respect of communal land, establishment of Communal Land Boards, empower and clarify the roles of Chiefs and Traditional Authorities and boards in relation to communal land.	Section 24 provides the procedures to acquisition of communal land rights. Moreover, where there are grievances, procedures to be followed are prescribed

Chapter 5

5. Description of the Receiving Environment

5.1 Climate

The Zambezi Region area lies within the tropics, characterized by a higher rainfall, less evaporation and a warmer winter relative to the rest of Namibia (Mendelsohn & Roberts, 1997).

5.1.1 Temperatures

The highest temperatures are between September to November when there is less cloud cover and average daily maximums of 32-35°C can be reached. In the winter months, the region has a more moderate winter than the rest of Namibia with maximum daily temperature of between 18 -25°C and minimum temperatures of 5°C. Frost is unusual in the Region, but may occur in some years in low-lying river valleys, especially in the western part of the region (Mendelsohn & Roberts, 1997). The annual average temperatures for Katima Mulilo is 22°C (Figure 22).

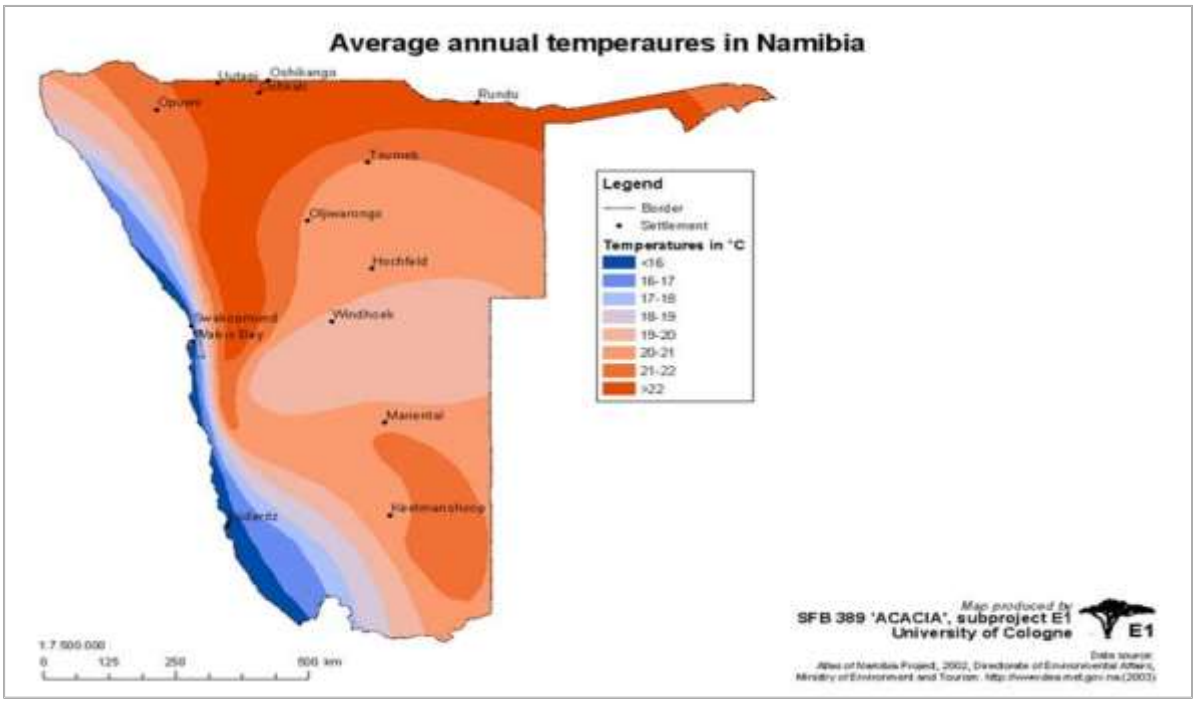

Figure 22 Average annual temperature in Namibia

5.1.2 Precipitation

Rainfall averages about 700 mm per year in the wetter northeast, and about 500 mm in the southern Zambezi Region. The climate can be divided into two main seasons – a dry season between April and November, and a shorter wet season that stretches from November to early April. Rainfall, as in the rest of Namibia, is highly variable, with standard deviation values from 30–40% (Mendelsohn & Roberts, 1997). While Zambezi Region receives the most rainfall in Namibia, in an international context, it remains considered dryland and is manifested in the high evaporation rate.

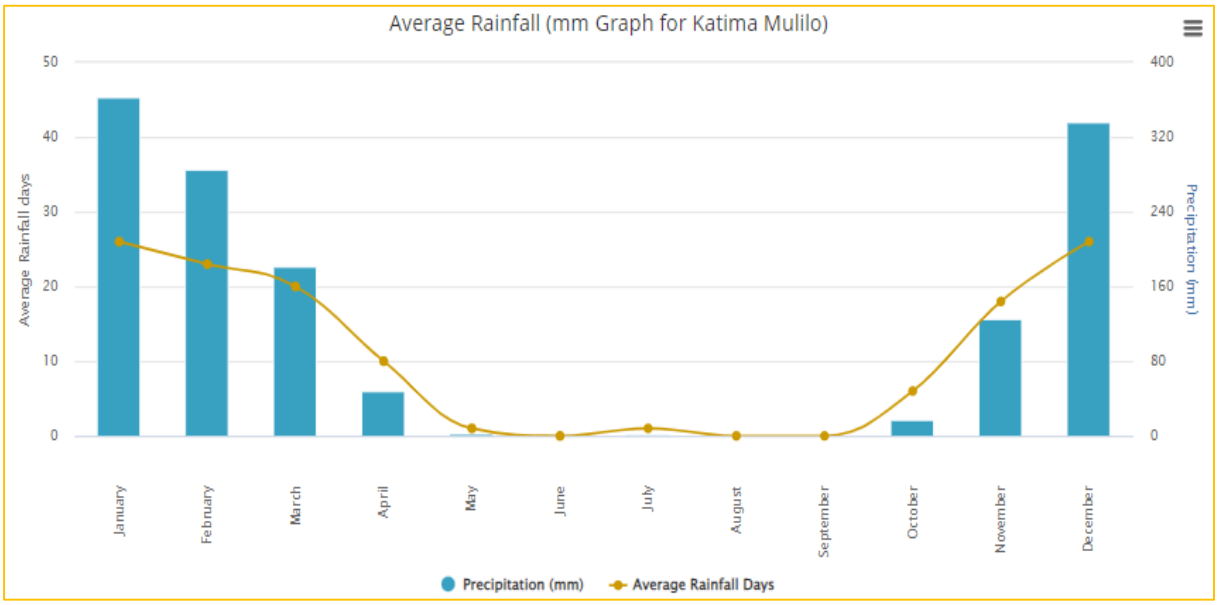

Figure 23 Rainfall pattern over the Zambezi region

5.1.3 Evaporation

The highest rate of evaporation takes place during the months of September to October when it is considered very hot, dry and clouds are sparse. The potential evaporation of 2,500mm is over four times the volume of water normally provided by rain (Mendelsohn & Roberts, 1997), thus the proposed site has high evaporation rate and most accumulated water lost.

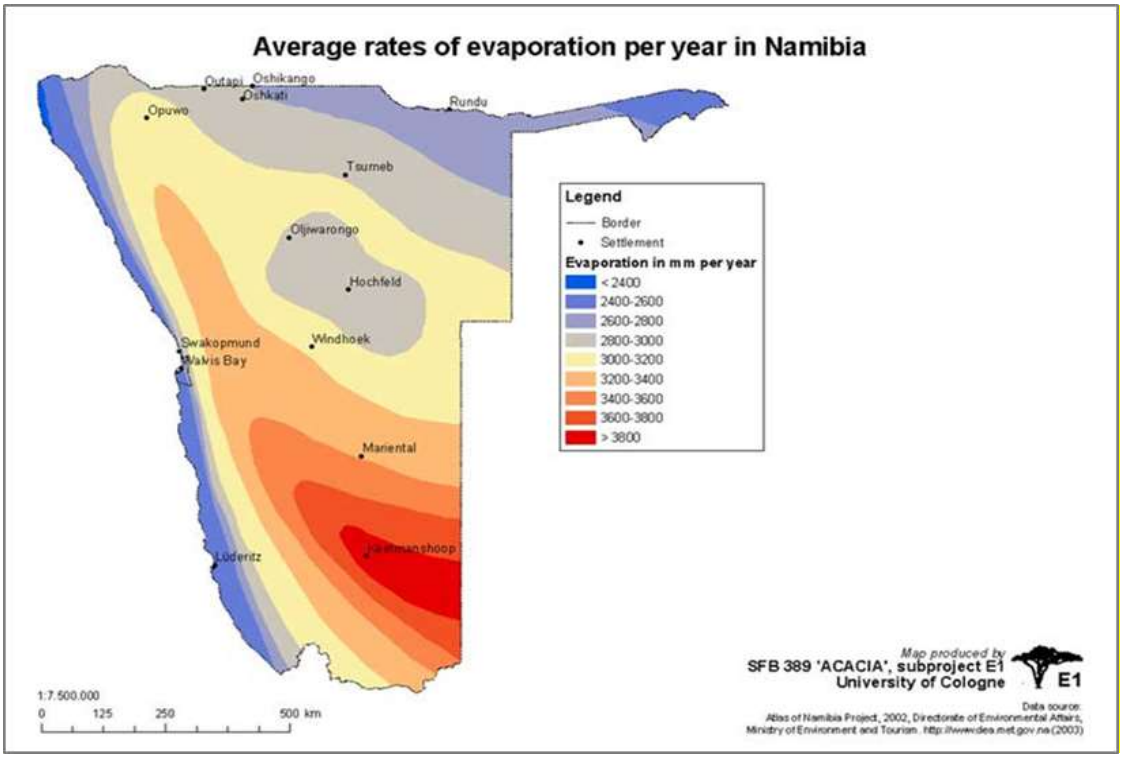

Figure 24 Evaporation pattern over the Namibian landscape

5.1.4 Wind Direction and Speed

Wind speed and direction is a major factor of the air quality in the environment. The average hourly wind speed in Katima Mulilo experiences significant seasonal variations throughout the year. The windier part of the year lasts for 3.4 months, from August to mid-November, with average wind speeds of more than 8.7 miles per hour (Figure 25). The predominant average hourly wind direction in Katima Mulilo is easterly winds throughout the year (Figure 25).

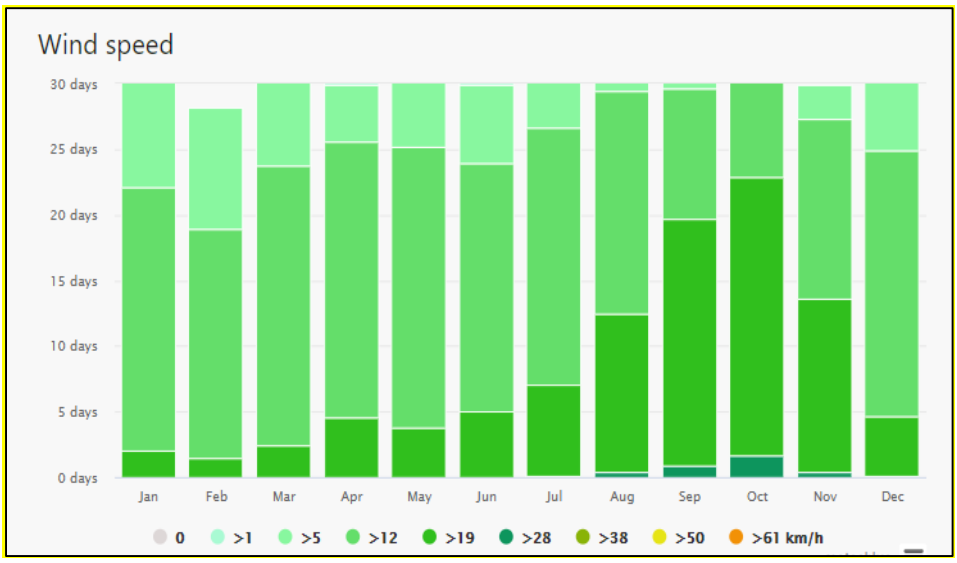

Figure 25 Wind direction and speed for Katima Mulilo

5.2 Topography

The entire Zambezi regions has a typical flat topography relative to the adjacent lands of neighboring countries. The regions topography declines eastwards to the flood prone areas. West of Katima Mulilo town, away from the Zambezi watercourse, the landscape is fairly elevated thus safe from annually expected flooding. The general aerial relief around the development site indicates no significant effect on surface flow although further influenced by

soil characteristics. Nonetheless, it is generally accepted that any surface flow will be eastwards, however much of this is collected in depressed areas and eventually evaporates and some infiltrated.

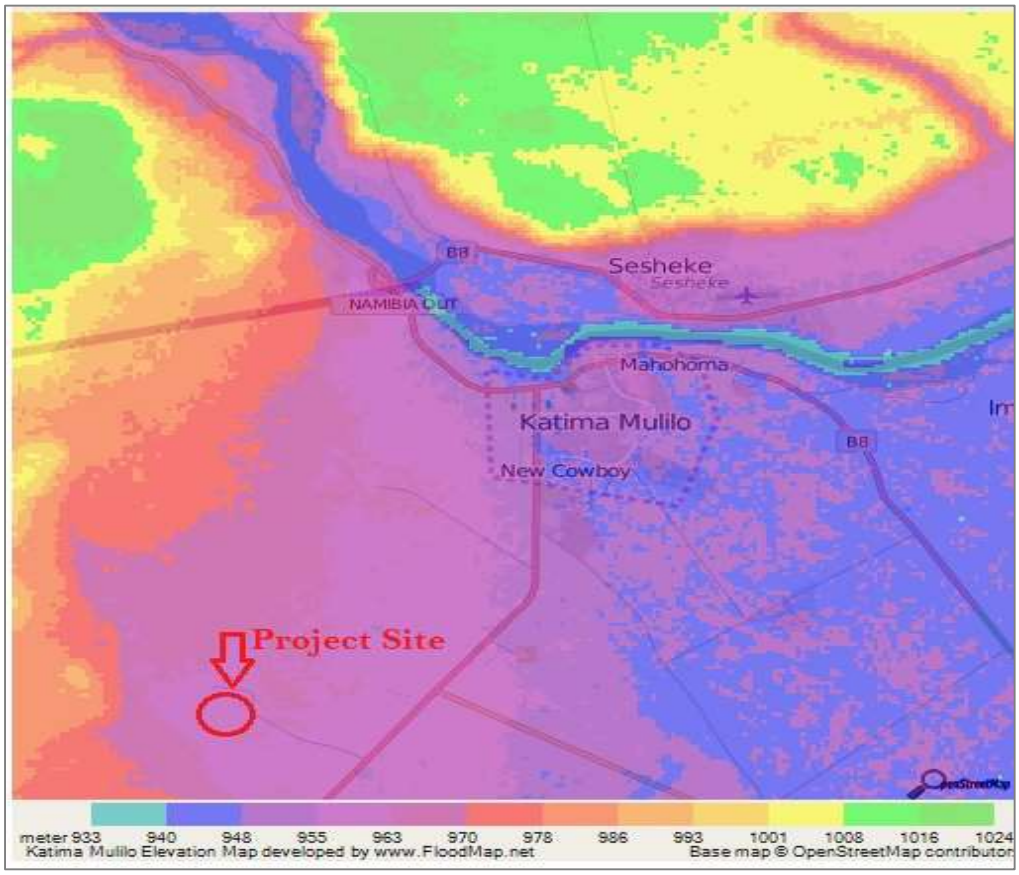

Figure 26 Topography relief of the area around Katima Mulilo

5.3 Hydrology

The Zambezi region is bordered by four perennial rivers; the mighty Zambezi in the north, the Kwando in the west adjoining the Linyanti in the southern parts connected to the Chobe through the Liambezi marsh in the east (MLR, 2015). Therefore, the region falls within the greater Zambezi basin drainage system. The proposed project site is about 11 kilometers from the Zambezi watercourse.

Aerial view of the area of the project site provides no appearance of any direct surface drainage pathways to the Zambezi River; however, the general surface and subsurface water

interaction cannot be overlooked, as it widely accepted that streams rely on base flow to maintain surface flow in drier times, and the reverse in seasons of high stream flow. Margane et al. (2005) points out that a trend towards effluent groundwater system is observed mostly in the north, west and south of the region.

5.4 Geology and Soils

The Zambezi Region is characterized of the Kalahari Group formations extensively overlaying much of the eastern, northern to northeast parts of Namibia. The thickness of Kalahari deposits in this area is described as exceeding 150 m, however, the lithostratigraphic differentiation the deposits is yet described to date (Margane et al. 2005). Generally, the Kalahari sequence formation are characterized of unconsolidated to semi-consolidated sand and gravel, locally calcrete and calcrete cemented conglomerates.

The Zambezi region is characterized under the extensive Kalahari basin that formed over 130 to 180 million years, much of the soils of the region are characterized by sand shaped into dunes. Largely the soil texture determines the classification of the soil, westward of the region from the flood prone east; soils are more characterized by sand content (Mendelson and Roberts, 1997). These soils are called aerosols and are extremely poor in nutrients as water drains through the sandy texture easily and little water is held in the surface layers where most plants have their roots. An inspection of the area seems to indicate the appearance of sandy loamy and clay layers with increasing depth around the site as described by Mendelson (1997; 2006).

Figure 27 Clay sediment layers underlying the brownish sand/loamy overburden.

5.5 Hydrogeology

The hydrogeology of the area is well described in the specialist report in Appendix B to this report. A brief description provides that the vast Zambezi region as underlain by the Kalahari sequence rocks which comprise mostly primary aquifers, however shows high variability in occurrence over small distances. Close to watercourses, groundwater is shallow with surface to groundwater interaction expected.

Groundwater usage in the area exits but limited in extent within 1km radius of the site (only a single water point) but a few more beyond the 1km radius with up to three water points detected.

The groundwater quality of the area is good from the results detailed in the hydrogeological assessment.

5.6 Biodiversity

5.6.1 Fauna

The Zambezi region is a key area for wildlife that moves freely within and beyond to neighboring countries (Chase 2009). Surveys carried out in the Zambezi region on wildlife, have come to conclude that wildlife numbers in the region are on a generally trajectory trend due to facilitation of transboundary movements through KAZA and due to the concept of conservancies that supports community livelihoods (MLR 2015). Nonetheless, the site for the envisaged landfill establishment is away from communal conservancies or wildlife migration routes and the presence of wildlife in the areas is not a common phenomenon. Moreover, the constant presence and movement of people in the area exacerbate this but also the disturbance of the site and surroundings makes it unsuitable for wildlife habitats or movement.

5.6.2 Flora

Zambezi Region is covered mostly by Kalahari sands and is composed of six land types that form broadly six vegetation communities: open water, floodplains, riverine woodlands, Mopane woodlands, Kalahari woodlands and Impalila woodlands. Within each of the six broad vegetation communities, certain plant types exist better than in others. The major trees species found are *Baikiaea plurijuga* (Teak), *Barkea Africana*, *Pterocarpus angolensis*, (kiat), *Brachystegia, Julbernardia*, Mopane and Zambezi Teak. Locally other genera such as *Acacia, Combretum* and *Terminalia* are important.

The acquired site is classified under the state forest in the land use plan for the region and is surrounded mainly by *Acacia erioloba* that are on the extreme edges around the pit. *Acacia erioloba* is a protected species and thus massive removal can only be carried under authorization by the regulating authority.

5.7 Cultural Heritage

The previous activities that have scarred the site are an obvious sign that the site it not a declared heritage site. Moreover, a review of the National Heritage Council of Namibia listed heritage sites confirms the above assertions. Nonetheless, the National Heritage Act provides

necessary protocols in case of encountering certain artefacts in the implementation of the project.

5.8 Land Uses

Liselo is located on the outskirts of Katima Mulilo in the communal area that comprises of mix use such as villages, fields and animal grazing. This is the general characteristic of rural setups in the communal areas of the country. In the surrounding of the site, there is an active burrow about a kilometer in the southern proximities for gravel and for sand mining. The surrounding of the site is further characterized by crop fields utilized for seasonal farming, with nearest field a distance of approximately 100m, north of the site.

The nearest permanent settlement is at least 1.5km from the site along the road leading to the highway. Although there are small huts indicative of villages in proximities, these are only occupied during the cropping season and near uninhabited at the end of the cropping season.

Figure 28 Land uses in the surroundings of the project site

5.8.1 Regional Integrated Land Use Plan

The integrated land use plan for the Zambezi (MLR, 2015) proposed this area to fall under state forest, however, such does not suit the site in its present state due to the massive scars it bears. The surrounding areas further bears two massive burrow pits, one to the north and another south to the acquired site, with the latter a recent development and active, while the former mined occasionally.

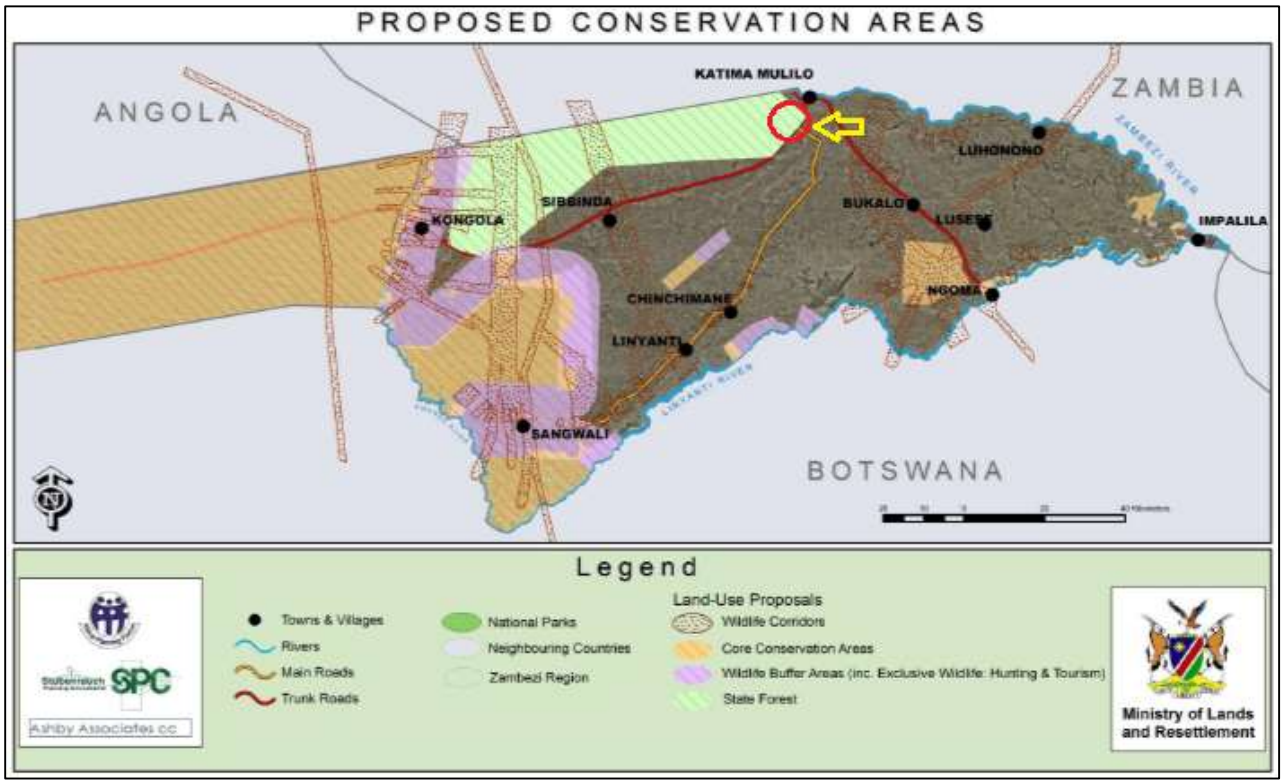

Figure 29 Proposed Regional land use plan

5.8.2 Local land use applications

The existing and land rights applied for in the surrounding of the site are mainly crop fields (i.e. farming units), residential and gravel burrow pits (i.e. leasehold).

5.9 Socio-Economics

The proposed Liselo Landfill site is located within Katima rural constituency, 5km outside the Katima Mulilo local authority. There are different socio-economic activities that make up

the social wellbeing, demography and economic status of an area. There are no economic activities taking place around the proposed site.

5.9.1 Demography

The population of the Zambezi Region has grown from 79,826 in 2001 to 90,596 in 2011, with an annual growth rate of 1.3% that is slightly lower than the national average of 1.4% (NSA, 2014). The population density of the region was 6.1 persons per km² in 2011, which is much higher than the national average of 2.6 persons per km², indicating possible land use pressures (NSA, 2014). Katima Mulilo Urban Constituency had the highest density amongst the constituencies with 880 persons per km². Katima Mulilo is the only major urban area and its population has increased from 22,134 people in 2001 to 28,362 in 2011. The constituency with the next highest population densities is the Katima Mulilo Rural (16 399) with eight persons per km^2, and this is largely due to their proximity to Katima Mulilo.

The majority of the population (55%) of the Zambezi Region is in the economically active age group of 15–59 years and the majority of them (61%) live in the urban area. The rural areas have more young children and people over 60 years (NSA, 2014). This is consistent with the urbanization trend that usually sees the younger people moving to the urban areas and the older people staying or returning to the rural areas to continue with farming activities.

Demographics of the Liselo area cannot be isolated to those of the overall constituency in which the area falls.

5.9.2 Health and Education Facilities

The location of the Liselo Community in proximity to town of Katima Mulilo is resultant of the reliance on town's health and education facilities, except for a primary school located at the turnoff to the project site. No clinic or high school is located in the area. While this is some disadvantage, the proximity to town is beneficial in that they are in a

minimal distance to the regional State hospital, several high schools relative to some remotest areas of the region.

Prevalence of sexually transmitted diseases (STDs) such as HIV stands at 22.3% for the Zambezi region, the highest among all the regions of Namibia among adults aged 15-64 years (MHSS, 2016).

5.9.3 Employment and economics activities

There are no major economic activities in the area to provide employment to the most active age group. Subsistence agriculture such as livestock rearing and rain fed seasonal cropping provides the minimal activities to support livelihoods of the rural people. Nonetheless, proximity to the Katima Mulilo town is an advantage in that community members have opportunity to seek employment and economic prospects in town, while maintain a rural livelihood setting. Projects that may offer opportunities even to a minimal number of the people of the area will go miles in improving economic status of the area and uplift the wellbeing of the people.

Chapter 6

6. Public Participation

6.1 Legislative Requirements for Public Participation

Sections 21-24 of the Environmental Regulations (GN 30 of 2012) prescribes the components of the process of public consultations. Therefore, this chapter elaborate on the steps taken in meeting the prescribed legislative requirements.

6.2 Stakeholder Identification

The following stakeholders were identified for active engagement by the consultants throughout the process of the EIA. The listed are not the only interested and affected parties for engagement, however, placing of notices aims to invite a broad spectrum of I&AP's to be closely engaged throughout the process.

Table 5 Identified stakeholders

Stakeholder	**Purpose**	**Responsible**
MEFT	Notice of intent to conduct an EIA and submission of an application for an ECC.	Consultant
Zambezi Regional Council and Councilors	Pivotal to Regional planning and development	Consultant
Community of Liselo	The communities living in surrounding of the site.	Consultant through sub-Khuta
Local sub-Khuta of Liselo	Communication was made with the local traditional authority of the Liselo through the secretary of the Khuta informing them of the proposed activity and the planned meeting for public consultation at the Khuta premises. The Khuta acknowledged the process and	Consultant

	assisted in informing and getting people to attend the public meeting.	
The Mafwe Traditional Authority	The overall custodian of the respective communal land in the area	Consultant through the Town Council
Town Residents/Institutions	Information sharing for comments, inputs and advice	Consultant

6.3 Public Notices

6.3.1 Newspaper notices

Notices were placed in daily newspapers distributed throughout the country. These briefly described the proposed activity, its location, the proponent and invitation for the public to register as interested and Affected Parties (I&AP's) (Appendix H).

Table 6 Newspaper Notices information

Date	**Publication**	**Distribution**
20 September 2021	New Era	Nationally
27 September 2021	New Era	Nationally
21 September 2021	Namibian	Nationally
28 September 2021	Namibian	Nationally

6.3.2 Poster Notices

Posters with description of the activity, an invitation to a public consultation meeting (i.e. detailing the date of the meeting, the venue and time) were prepared and placed at various strategic points in the town and in the community. The posters were posted at the following points; The Liselo sub-Khuta premises, the Liselo Primary School premises, turn off point to the Proposed Landfill Site, Town Council Notice board and gate, Katima Mulilo open market gate and Ngweze community hall (Figure 30).

Liselo sub-Khuta

Ngweze Community Hall

Liselo School

Outside Liselo School

Town Council Premises

Katima Mulilo Open Market

Figure 30 Notice placements at various places in local area and town

6.4 Public Meetings

6.4.1 Liselo Community Meeting

The public meeting at Liselo sub-Khuta was held on the 7th of October in the morning hours. A sizeable number of community members of Liselo area attended the meeting as indicated in Figure 31. The concerns raised by the community are summarized in Table 7 and recorded in the minutes of Annexure C.

Figure 31 Liselo public consultation meeting

6.4.2 Katima Town Hall Meeting

The Community hall meeting was arranged on the 7th of October in the afternoon hours. This meeting was not attended by members of the public even after waiting for up to 3 hours (Figure 32).

Figure 32 Prepared community hall meeting

6.4.3 Regional Authorities Consultations

Consultation were further held with the Chief Regional Officer and officials of the Zambezi Regional Council at the Regional Council premises on the envisaged activities of the premises on the 8th of October 2021. Matter raised by the ZRC are summarised in Table 5 below and recorded in the minutes of Annexure C.

6.5 Summary of Issues and Feedback

Table 7 Comments and responses at public consultation meeting

Stakeholder (I&APs)	**Comments/Concerns**	**Feedback/Response**	**Way forward**
Liselo community meeting	The members of the Liselo community in attendance raised concerns of dissatisfaction with the process upon which the proponent was allocated the site as recorded in letter of the presiding traditional authority.	In response, the consultant reasoned that the consultants are not involved in the initial process of land allocation and acquisition but are only contracted to perform the EIA process after assurances of valid land rights to the piece of land are given. Thus the basis of the consultancy work bases on the letter of the MTA in Annexure D. Nonetheless, as independent intermediaries, the consultants will record the concerns of the community and report to the proponent with emphasis to device mechanism to address going forth.	At the meeting with the proponent on the 8th of October, the recorded dissatisfaction was relayed to the proponent and strongly advised to find amicable ways to bridge the relationship with the community.
Regional Council	Consideration should be given to potential groundwater pollution especially if there are users in the area	A specialist study to examine the potential risk and propose necessary protection where required is being conducted.	Taken up in specialist assessment.
	Determine land right types held in the area	Matter taken up in the report.	Addressed in report
	To consider provision for hazardous waste at the site given that the town is developing and may be needed for the future.	The matter was taken up, however it is considered unfeasible to construct the facility at the site than within town boundaries where it can serve for a lifetime.	Addressed in report
	Site utilization approach, is it phased or wholly from onset?	The site utilization plan as per layout will use a phased approach with the general waste cells 1 and 2.	Addressed in report

	Economic opportunities to prioritize locals to lessen social disturbance from immigration into the area but also extend benefits to them.	Initial opportunities in guarding the site have been already awarded to the locals. Other opportunities that will be established will prioritize the locals.	Addressed in report
MTA	The risk of groundwater pollution.	The risk of groundwater pollution has been considered critically and exists however based on characteristics required designs and other measures within the EMP, the risk is envisaged to be mitigated.	Addressed in the report
	Actual implementation of the plan as explained in the management and monitoring. What assurances are there for the proponent to implement the EMP.	It was explained that the EMP is a legally binding document that the Authorities will use to ensure that the proponent adheres to the commitments made.	Addressed.
	The resultant benefits be restricted to local communities and some compensation for losing be extended to the same community as this seems the cause of dissatisfaction.	Opportunities that have arisen preliminary such as guarding the site are already occupied by the locals. The compensation matters will be relayed to the proponent to consider and address where possible.	The possibility for compensation was relayed to the proponent at the meeting of 27 November 2021 for consideration.
	The site be secured to ensure safety of nearby communities and livestock.	the site is already guarded at the moment prior erecting a fence once approvals for site utilization are in place.	Addressed in report.

Chapter 7

7. Impact Assessment

7.1 Identification of impacts

The Potential impacts of the proposed activity were identified based on the details of project activities and their potential interactions with the surrounding environment (physical, ecological, and/or human receptors). The understanding of the potential sources of impacts and impact pathways is supported by:

i. An understanding of baseline conditions and potential receptors
ii. The spatial and temporal extent of the project area of influence
iii. Information from stakeholders, including authorities, experts, and the public
iv. Professional knowledge and experience of comparable projects or developments.

In order to identify the project activities that will have a direct or indirect effect on the environment the following will be considered:

- Actions involving emission of pollutants (smoke or harmful gases, noise and water)
- Actions involving a modification of hydrological or hydrogeological patterns
- Actions involving a modification in the soil quality and structure
- Actions acting on the biotic environment (flora and fauna)
- Actions involving damage of the landscape
- Actions affecting infrastructure (services)
- Actions modifying the social, economic and cultural environment

Based on the described methodological approach above, impacts are identified and described for each of the activities envisaged.

Table 8 Impact identification on natural resources

Resources/Receptor	**Impact type**
Air quality	Ambient air quality disturbance (dust and smoke) Odours

	Vehicle emissions
Land	Soil disturbance Littering of surrounding landscape
Water environment	Groundwater quality pollution from construction and landfilling activities.
Biodiversity	Removal of indigenous, endangered and near-threatened to threatened fauna and flora species Luring of wildlife into the area
Social-economics	Safety and health of the employees and community Safety and security in the area Employment opportunities Noise and vibrations Social disturbance due to luring of waste scavenges

The above identified impacts are associated to each of the activities through the different phases of the activity in part 3.6 of this report.

7.2 Impact Assessment Methodology

Environmental risk assessment is carried out to identify a potential risk and to enable risk management decisions to be made. This process involves identifying, evaluating, selecting, and implementing actions to reduce risk to human health and ecosystems. Risks from a proposed activity can be managed in ways including; elimination of the risk, transfer, retention of the risk or reduction of the risk or accept the risk.

This impact assessment methodology was applied to activities to be able to determine those that are significant and requires mitigation in the implementation phase of the proposed activity. The degree of confidence in the assessment relies primarily on the level of information available and the expertise and experience from activities of other projects.

The following significance rating method will be used to rate impacts emanating from the proposed landfill site activities:

Significance of the Impact(s):

Each category will be assigned points. These points will be computed using the equation devised below and each potential impact assigned an impact significance rating (IS).

Therefore: **IS= (IE+ID+IM) * IP**

Table 9 Impact evaluation parameter description

Parameter	**Character**	**Description**	**Code**
Impacts Nature (IN)	Adverse	Impact has negative impact	-
	Beneficial	Impact has potential benefit	+
	Neutral	Neither adverse or beneficial	0
Impact Probability (IP)	None	Will never occur	0
	Improbable	In exceptional cases	1
	Probable	Could occur at some point	2
	Likely	Might occur	3
	Highly likely	Expected to occur	4
	Certain	Will occur	5
Impact Extent (IE)	Project site	Limited to the project site	1
	Local	Beyond the boundary of the project site	2
	Constituency	Beyond local surroundings over 10km away	3
	Regional	Over 50 to 100km	4
	National	extend to other regions and or beyond the border	5
Impact Magnitude (IM)	No effect	None	0
	Negligible	Limited damage to minimal area. Restricted to the project site and immediate surrounding	4
	Moderate	Short term impacts but not affecting the ecosystem or community functioning, may be rehabilitated in a very short time	6
	High	Very serious long term impacts impairing ecosystem or population functioning. May take a lifetime to recover.	8
	Very High	Irreparable damage	10
Impact Duration	Immediate	less than one year	1
	Short term	between one year & five years	2
	Medium Term	between five years & 15 years	3

	Long term	impact ceases after operational life span of the project	4
	Permanent	Impacts lasts a human lifetime	5

The significance ratings below will determine the action required on each impact as per table 10 below.

Table 10 Impact significant description

Scale	**Significance level**	**Abbrev**	**Description**
IS < 25	Not significant	NS	The impact is not substantial and does not require any mitigation action.
25> IS <48	Low significance	LS	Some minimal measures or monitoring may be required for this activity
48> IS <60	Moderate Significance	MS	Mitigation measures required
IS <75	Highly Significance	HS	Mitigation Critical, project may not go ahead

7.3 Impact Evaluation and Mitigation Controls

Activity/Aspect	Impact	IN	IP	IE	IM	ID	IS	Mitigation measure
Preconstruction								
Finalize site layout plan	Site utilization align with envisaged new waste management approach	+	4	1	6	4	**33**	○ Ensure that site layout plan is approved.
Demarcation and marking of areas per site layout plan		+	4	1	6	2	**36**	○ Delineate the areas as per site layout plan ○ Place signage to mark demarcated areas as per final site layout plan
Construction								
Earthworks and construction of structures (fence, office, guardhouse, septic tank, sorting shelter, weighbridge, medical residual waste burial area and evaporation pond)	Soil disturbance of adjacent surroundings	-	4	1	4	1	24	
	Clearing of sensitive/protected vegetation	-	5	1	4	1	**30**	○ Identify healthy protected trees and mark them to avoid removal ○ Fence perimeter path to consider the location of healthy protected trees to avoid their removal. ○ Ensure that all trees marked for avoidance are known to site workers.
	Littering of surrounding landscape	-	4	2	4	2	**32**	○ Designate specific points for disposal of construction waste materials and other unusable substances brought to site. ○ Place signage on disposal points for visibility. ○ Good housekeeping practices are required. ○ All loose materials and packaging from all site activities collected and disposed at specific designated points. ○ All contractors and their workers to be inducted of the required good housing keeping practices.

								○ Assign responsibility to monitor housekeeping practices.
	Theft of construction material	-	2	2	6	1	18	
	Safety and health of the construction workers onsite	-	3	3	8	1	**36**	○ Provision of Personal Protective Equipment (PPE) such as safety shoes, gloves, goggles and overalls to all employees; ○ No employee must be allowed in working areas without necessary PPE ○ Operations should be restricted between 07H00 to 17H00. ○ All contractors required to ensure they conduct basic first aid and safety awareness training for its employees. ○ Site movement to minimized and controlled ○ Signage be placed where heavy machines will be actively working ○ No authorized persons should be allowed onsite. ○ Any persons authorized but unfamiliar with operations to be accompanied.
	Dust generation	-	5	2	4	1	**35**	○ Activities with high dust generation potential such as excavation to be avoided under high wind conditions ○ Roads leading into the site to be sprayed using a water tank during dry periods of the year. ○ Vehicular speed inside the site be reduced to maximum of 40km/h. ○ Avoid unnecessary movement of construction vehicles

								○ Construction work limited to normal working hours (7am to 5pm).
	Noise and vibrations	-	4	2	4	1	**28**	○ Restrict working time to normal working hours (7am to 17h00). ○ Regular servicing of vehicles and machines to remove excessive noises
	Release of noxious gases into the environment	-	5	2	4	1	**35**	○ Regular servicing of vehicles to minimize the release of noxious gases. ○ No unnecessary operation of machines/vehicles.
	Accidental leakage or spill of oils/fuels onto soils/groundwater.	-	3	2	8	3	**39**	○ Use of trays when fueling to prevent spillages to the ground. ○ Fueling activities to be monitored by experienced persons onsite. ○ Vehicles be checked regularly in the morning for signs of leakages/drippings and effect corrective action where necessary. ○ Any fuels and oils brought to site must be locked away and register for access kept.
	Covering of the hand dug well water sources	-	5	2	6	4	**60**	○ Provide alterative drinking water point for dependent nearby community and livestock.
Operations								
Waste disposal at source, removal and loading of waste by contractors, and	Waste separation at source	+	4	2	4	5	**44**	○ Provision of different waste separation containers for public spaces. ○ Initiate a public awareness program on waste separation for schools and the public.

transportation to landfill site								○ Identify an environmental youth group or schools and support in addressing environmental topics including problems of waste. ○ Initiate demonstration projects at council premises on waste separation practices. ○ Engage businesses with large premises for placement of waste separation demonstration containers. ○ Place notices at different sites indicating penalties for illegal dumping or littering in hotspot areas. ○ Identify area for placement of skip containers for domestic rubble and garden waste and mark accordingly. ○ Acquire skip containers for waste separation.
	Differentiated loading of waste at source by contractors	+	4	2	4	5.	**44**	○ Induction of contractors on procedures required for waste handling at loading points. ○ Monitor contractors regularly to comply with measures initiated to separate waste at source. ○ Dedicate a contractor towards rubble and garden waste collection with appropriate trucks. ○ Reuse of clean rubble waste as fill material for some depressed surfaces or roads. ○ Contracts of waste contractors to induce clauses on required waste handling practices.

	Securing of waste with nets during transportation	+	4	3	6	1	**40**	○ Maintain current practices of all waste trucks to have mesh/nets or cage to secure all waste when transported from town to landfill site. ○ Inspect waste trucks for securing of waste when transported to site.
	Health and safety of waste collectors	-	3	1	8	5	**42**	○ Provision of Personal Protective Equipment (PPE) such as safety shoes, gloves, eye wear and overalls to all employees; ○ Conduct first aid and safety awareness training for contractors ○ Schedule inspections and audit of the practices of the contractors for compliance.
Onsite waste weighing and subsequent offloading.	Records of waste volumes handled at the site	+	5	2	0	4	**30**	○ Construct platform at the gate for weighbridge ○ Acquire mobile weighbridge unit for installation at the site. ○ Assign responsibility of weighing and recording information associated with waste vehicles to the site. ○ All waste carrying vehicles pass through the weighbridge for weighing. ○ Regular auditing of the records for compliance to required record system.
	Waste offloaded in appropriate demarcated areas	+	5	1	0	5	**30**	○ Place signage of the various areas for offloading different type of waste. ○ Waste contractors should be inducted on site utilization layout ○ Weekly inspection of the site to ensure compliance.

Handling and treatment of waste comprising of picking recyclables for sorting, incineration of some material, chipping of garden waste, and landfilling (i.e. compacting and covering)	Recyclable materials removed from general cell	+	4	2	4	4	**40**	○ Initiate waste picking and sorting activity at the landfill site. ○ Acquire waste pickers and sorters for picking of recyclables and reusable materials and package them ○ Engage local known waste recyclers to explore possibilities and interests in waste collected and packaged at site. ○ Ensure adequate storage space for packaged waste prior collection by recyclers. ○ Keep a record of the details of recyclable or reusable waste collectors to ensure tracing where liability for offsite use arise.
	Safety and health risks of pickers and sorters.	-	2	5	10	5	**40**	○ Provision of Personal Protective Equipment (PPE) such as safety shoes, gloves, eye wear and overalls to all employees; ○ Conduct first aid and safety awareness for workers.
	Opportunities for locals in picking and sorting of waste	+	4	2	4	4	**40**	○ Priority be given to locals for non-qualifying job opportunities in waste picking and recycling ○ Where qualifying positions are available, locals be given advantage
	Flying litter in surroundings area of the landfill site	-	4	3	6	5	**56**	○ A compactor or other earth moving machine be stationed at site to shift and gather waste offloaded, compact on daily basis to prevent flying into adjacent land. ○ All litter that gathers around the fence should be regularly cleaned through manual picking.
	Increase in vermin, flies and pests in the surrounding area	-	4	2	6	4	**48**	○ Adequate daily covering of landfilled waste on the general waste cell.

	Luring of waste scavengers to the site to collect food and other reusable and recyclables	-	4	3	8	4	**68**	○ Access to the site be controlled by lockable gate. ○ Place 24-hour security personnel to control access and record all authorized entries to the site. ○ Job opportunities reserved for locals to limit immigration into the area
	Luring aggressive wild animals to the site	-	3	2	8	4	**42**	○ Daily compacting and covering of the general waste cell ○ Regular sighting (observation) and recording of wild animals in the area. ○ Conduct nearby community visits to determine eminent concerns that may arise and device measures to address where possible.
	Leachate generation to subsurface environment.	-	5	2	8	5	**70**	○ Ensure construction of base layering of general waste cells as per design requirements. ○ Drilling of boreholes up and down gradient of the site. ○ Quarterly borehole water quality sampling and testing ○ Inclusion of identified private water points for water quality sampling and testing over lifespan of the site. ○ Analysis of results and interpretation of any deviation from baseline conditions. ○ Regular reporting to the regulatory authority of the results from the monitoring program with adequate measures to address concerns.
	Generation of odour	-	5	2	8	4	**70**	○ Daily compacting and adequate covering with sand/clay material

	Generation of smoke into surrounding area	-	4	3	6	4	52	○ No open burning of waste to be allowed prior acquiring an incineration unit ○ Schedule incineration for few days (2-3) a week spaced with up to 2 days in-between to avoid continuous smoke retention in the atmosphere. ○ Incineration of waste to be monitored frequently by the health/environmental officer ○ Limit incineration on windy days and months of the year
	Accidental spillage of oils or fuels infiltrating to groundwater	-	3	1	8	3	**39**	○ Use drip trays when refueling of earth moving vehicles onsite ○ Daily inspection of vehicles for signs of leakages and or spills and keep record
	Landfilling as per operation design recommended	+	4	1	4	4	**36**	○ The landfilling process to align with the cell recommended approach. ○ Weekly inspection of the landfilling approach for continued adherence.
Site access control (no town residents private or commercial entities to visit site without prior arrangement and approval of owner)	Opportunities in guarding of site	+	5	1	4	4	**35**	○ Priority be given to locals for non-qualifying job opportunities in waste picking and recycling ○ Where qualifying positions are available, locals be given advantage
	Town residents do not interfere and or disrupt site operation.	+	5	1	4	4	**35**	○ No town residents to be allowed access site to dispose waste until prior approval is provided. ○ No commercial agencies allowed to dispose waste at site without making prior arrangement and agreement with site proponent.

								○ All waste coming into the facility should be weighed and guided to appropriate area. ○ Avail drop-off waste skips at the gate area for residents and nearby communities. ○ Keep a register of waste brought to site
Decommission phase								
Stakeholder engagement on land end land use	Consolidated decision of site end use.	+	4	3	4	5	**48**	○ Maintain and update the list of stakeholders established for engagement on end land use ○ Device a stakeholder engagement plan ○ Implement stakeholder engagement plan on end land uses
Application for decommission of the site.	Approval of the site closure plan	+	5	1	4	4	35	○ Implementation of site decommissioning activities. ○ Obtain decommissioning certificate or letter where applicable.
Demolition of unusable structures, cleaning and landscaping and	Dust generation	-	4	1	4	1	24	
	Noise generation	-	3	2	4	1	21	
	Risk to the safety and health of the workers.	-	3	1	8	5	**42**	○ Provide PPE to the workers ○ Induction on safe working practices for demolitions workers
Site closure and after care	Pollution of groundwater from leaching of landfilled waste over time.	-	3	2	8	5	**45**	○ Groundwater sampling and monitoring to continue post closure of the site. ○ Analysis of results and interpretation of any deviation from baseline conditions. ○ Regular reporting to authorities

Site access control	No access to site until end use is approved by all stakeholders.	+	4	1	4	5	**40**	○ Secure all access routes into the site. ○ Monthly inspection the site for breached access and rectification of any breaches.

7.4 Hydrogeology Specialist Assessment

7.4.1 Study Approach and ToRs

It was determined in the scoping phase that a hydrogeology assessment is required as part of this assessment due to the nature of the project and nature of the site. Previous activities that utilized the site reduced the depth to water level. Further to that, although the classification of the site indicates sporadic leachate generation, there remain potential that leachate may be generated, thus an assessment was important to provide baseline resource quality conditions and provide details of associated natural processes that may be affected and how such can be monitored. The terms of reference for the assessment were set out as follows;

i. Provide a geological and hydrogeological characteristic description of the site
ii. Provide a description of the extent of the groundwater level or water table
iii. Establish local groundwater direction
iv. Establish baseline groundwater quality of the area
v. Establish characteristic groundwater use in the area

7.4.2 Assessment Results

The results of the study are contained in Annexure B of this report, however, in summary, the site has good groundwater potential from existing borehole information. The yields although variable are significant with groundwater flow towards the south to southeast aligning with topographical nature of the entire Zambezi region.

The quality of the water is generally good with minimal to no notable concentrations of above acceptable drinkable water standards.

The proposed activity has some potential risk to the groundwater, however, the characteristics of the site and required design specification can provide containment for any potential leachate that may sporadically be produced over time.

7.5 Cumulative Impacts

Cumulative impacts are those impacts that may be of low significance on their own, but may become of high significance when added to similar impacts emanating from various sources in the surrounding area where an activity is undertaken. The activities may be from those identified and discussed in the above sections. Among such that may emanate are the following;

- The emission of methane gas into the atmosphere as a greenhouse gas contributes to contributes the climate change challenge. However, studies indicate that covering of waste may reduce the release of methane into the atmosphere, although such may not completely extinguish the process.
- It is likely that the number of trips undertaken by the waste trucks to site may cause increased traffic on the road and thus result in higher risk of accident for road users. This is less considered although it is evident, the number of trips to the site per year will total an average of 9 000 times. Although a minimal distance, the constant movement will have some impact on road usage by others however not easily quantifiable.

The impacts mentioned above do not only affect the environment within the proposed site or surrounding area in terms of the Biophysical environment, but may also impact on the health of communities beyond the site. Moreover, mitigation of these required complementary efforts with other regional effort to mitigate. Such may include;

- Support road safety efforts
- Support or initiate mobile healthy clinics to communities in the rea for checkups.
- support sustainable activities such as agriculture

Chapter 8

8. Environmental Management Plan

The Environmental Management Plan is attached in Annexure A. This Environmental Management Plan (EMP) is a risk strategy that contains logical framework, monitoring programme, mitigation measures, and management control strategies to minimize environmental impacts to be implemented during the sequential project phases. It further stipulates the roles and responsibility of persons involved in the project. Its adequacy to address adverse impacts and implementation is critical to the clearance of the envisaged activity.

Chapter 9

9. Conclusion and Recommendations

9.1 Conclusion

The proposed waste site is adequate to cater for at least 30 years based on conservative estimation of the lifespan, however with full implementation of prescribed new approach to waste management, the lifespan of the site can extend to further 40 or more years.

The allocated site is disturbed and further remained dormant for years' prior this envisaged use, except for minimal collection of gravel without any plans for site rehabilitation. The envisaged activities present an alternative rehabilitation plan to the site to improve its conditions, however, this cannot be undertaken without implementing measures that will ensure the envisaged activities present minimal negative impacts to the environment, communities and associated values whilst enhance the beneficial of utilizing the site. Therefore, the EAP for this envisaged activity provides recommendations in the next section required for utilization as envisaged.

9.2 Recommendations

The EAP recommends the following for implementations of this activity based on the following commitment to be made by the proponent;

- The envisaged New Waste Management Approach is adopted and practices aligned as detailed described in the entire EIA Report.
- Full implementation of the Environmental Management Plan for the site as contained in Annexure A of this report.
- Strive for cordial relations to the community and the traditional structures of the area.

References

Chase, M. 2009. Fixed-wing aerial wildlife census of the Caprivi river systems; a survey of rivers, wetlands and floodplains.

Christelis, G. & struck Meier, W. (2011): Groundwater in Namibia - an Explanation to the Hydrogeological Map.

Department of Water Affairs and Forestry's (South Africa) Minimum Requirements for Waste Disposal by Landfill, 2nd Edition (1998)

Mendelsohn J & C Roberts. 1997. An Environmental Profile and Atlas of Caprivi. Environ mental Profiles Project. Directorate of Environmental Affairs. Windhoek, Namibia.

Mendelsohn, J., Jarvis, A., Roberts, C. and Robertson, A. 2002. An atlas of Namibia. A portrait of the land and its people. New Africa books Pty. ltd. Cape Town

Miller. R. MG. 2008. Geological of Namibia. Geological Survey of Namibia. Ministry of Mines and Energy, Windhoek, Namibia

Ministry of land Reform.2015. Baseline Report (Volume 1) for the Zambezi Integrated Regional Land-use Plan

Ministry of Health and Social Services. 2016. Surveillance Report of the 2016 National HIV Sentinel Survey. Republic of Namibia.

National Planning Commission. 2011. National population and housing census; Caprivi regional tables based on 4th delimitation.

List of Annexures

The following annexures are complementary of this report

Annexures	**Item**
A	Environmental Management Plan
B	Hydrogeological Assessment
B.1	Department of Water Affairs-Water Quality Standards for Drinking Water
B.2	Proposed monitoring boreholes drill area
C	Minutes of the consultation meetings
D	Letter of the Traditional Authority
E	Proponents Request for temporal use of the new site
F	MET Temporal Authorization for Use
G	Proposed Fencing for the Site
H	Newspapers Notices
I	Environmental Assessment Practitioner CV's
J	Basic septic tank design

Annexure B

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED ESTABLISHMENT, OPERATION AND DECOMISSIONING OF A LANDFILL SITE IN THE LISELO AREA, KATIMA MULILO, ZAMBEZI REGION

Hydrogeological Assessment

December 2021

Namib Consulting Services CC
Geoscience and Environmental Consultants

Table of Contents

Abbreviations iv

1. Introduction 1

1.1 Background 1

1.2 Objective 1

1.3 Site Description 1

1.4 Project Description 2

1.5 Landfill Site Classification and Design 3

2. Legislation 4

3. Baseline Description of Locality 5

3.1 Geology 5

3.1.1 Regional Geology 5

3.1.2 Local Geology 5

3.2 Hydrogeology 6

3.2.1 Regional Hydrogeology 6

3.2.2 Local Hydrogeology 7

3.3 Groundwater Flow Directions 8

3.4 Hydrocensus Survey 9

3.4.1 Hydrocensus Survey Findings 10

3.4.2 Interpretation of Findings 12

3.5 Groundwater Chemistry 12

3.5.1 Groundwater Quality 12

3.5.2 Interpretation of Water Quality Data 13

3.6 Groundwater Usage 14

3.7 Conceptual Model of Envisaged Landfilling 14

4. Impact Assessment 15

4.1 Description of Impacts Envisaged 17

4.1.1 Preconstruction phase 17

4.1.2 Construction phase 17

4.1.3 Operation Phase 17

4.1.4 Decommission phase 18

4.2 Impact Significance Assessment 19

5. Environmental Management Program 20
6. Conclusions and Recommendation 22
References 23
Annexures 24
B.1 Water Quality Guidelines (DWA-MAWLR) 24
B.2 Envisaged Drilling Areas 24

List of Figures

Figure 1 Construction design of general waste cell for a G:S:B- landfill site 3
Figure 2 Clay material underlying the top superficial material of sandy-loam soils 6
Figure 3 Depth to water level in boreholes 7
Figure 4 Borehole yields in the surroundings of the project site 8
Figure 5 Water level contours (blue lines) 9
Figure 6 Surveyed water points (boreholes) in 1.5 km radius 11
Figure 7 Hand dug well in burrow pit 11
Figure 8 Hand pump water point in surrounding area 14
Figure 9 Conceptual view of the envisaged landfilling of the acquired burrow pit 15

List of Tables

Table 1 Findings of the hydrocensus 10
Table 2 Water quality results of samples from the burrow pit and surrounding area 13

Abbreviations

EAP : Environmental Assessment Practitioner

ECO : Environmental Compliance Officer

DWA : Department of Water Affairs

mbgl : meters below ground level

MTA : Mafwe Traditional Authority

MAWLR : Ministry of Agriculture, Water and Land Reform

WP : Water Point

1. Introduction

1.1 Background

The Katima Mulilo Town Council intends to establish and operate a landfill site in the area of Liselo, on the outskirts of Katima Mulilo town. The site is located approximately, 5 km from the town boundaries in the communal land of the Mafwe Traditional Authority (MTA). The acquired site is an old burrow pit that was previously used for mining of gravel for road construction activities within the region but redundant over years.

This report is part of the Environmental Impact Assessment Report of the envisaged activity to establish and operate a landfill site in the Liselo area. This report is commissioned to specifically assess the hydrogeological setting of the area in light of the activities envisaged.

1.2 Objective

This assessment aims to assess the hydrogeological characteristic of the surroundings where the Katima Mulilo Town Council (The Proponent) intends to establish and operate a landfill site. The report assesses the potential risks of the envisaged activity on the groundwater resources and associated characteristics of the area.

The specific objectives are;

i. determine the overall groundwater potential and levels of the area
ii. establish groundwater flow direction
iii. determine the characteristic groundwater use in the area
iv. establish baseline groundwater quality of the area
v. conduct a qualitative assessment of the impact of envisaged activities on the groundwater system and develop mitigation controls where necessary.

1.3 Site Description

The project site is located in the communal area of Liselo, under the Mafwe Traditional Authority and administered through the local sub-Khuta of Liselo. The site was previously utilized as a burrow pit and appears to have ceased long ago, evident from observable revegetation inside the pit.

To the north of the acquired site are other burrow pits similarly excavated but smaller in size. Beyond the burrows, the surroundings are characterized of crop fields, cultivated seasonally by local communities. Some crop fields have temporal rural housing structures unoccupied at most except during cropping season time. The nearest field is a distance of 750m northward of the site.

1.4 Project Description

The envisaged activity involves establishment, operation and decommission of a landfill site at an existing dormant burrow pit and thus the acquired site can be characterized as a brownfield site.

The envisaged activity will undergo several phases, inclusive of planning in the preconstruction phase, the construction, operation and decommissioning phase.

In the ***preconstruction phases,*** all activities at the site need be guided into the later phases and thus requirement to develop a site layout or utilization plan. This will guide the delineation and demarcation of portions as per approved plan.

The ***construction phase*** involves constructing a fence around the site, establishment and construction of waste cell areas as per approved site plan with associated supporting structures. Envisaged structures include a site office with ablution facilities and security guardhouse.

Structures related to handling and treatment of waste include a shelter for sorting and packaging of recyclable waste. Incineration is envisaged as one of the treatment method for waste however such will occur in a prefabricated or built-up unit at the site. No hazardous waste is envisaged onsite accept residues from the state hospital incineration facility and such has been allocated area that will be designed of compacted base and controlled access inside the site.

The ***operational phase*** of the development will involve collection and removal of waste from town and transportation to site for further handling, treatment and landfilling. The envisaged waste management practices aim to implement a waste separation system at earliest initiation phase to trigger the course to reuse and recycling of some waste.

Waste handling at the site includes weighing of waste where possible on a weighbridge, offloading or deposition of different waste at appropriate demarcated areas, shifting of waste using a machine, compacting of waste on the general waste cell, and covering of waste with clay material. The above handling methods are complemented with treatment techniques such as incineration, chipping of plant or tree parts, picking, sorting and packaging of recyclables and reusable materials.

The ***decommissioning*** activities involve engaging stakeholder throughout the lifespan of the site on the suitable end land use. Moreover, it is expected that the site will require removal of any unusable structures, area cleaning, landscaping and aftercare.

1.5 Landfill Site Classification and Design

The MR2 requirements classifies the Liselo Landfill Site as handling general waste (G), small sized (S) due to the rate of daily deposition below 150 tons, and sporadic leachate generation (B^-) due to climatic moisture deficit, thus **G: S: B^-** classification. This entails that the required design or layering of the base of the landfilling cells is as provided as in Figure 1.

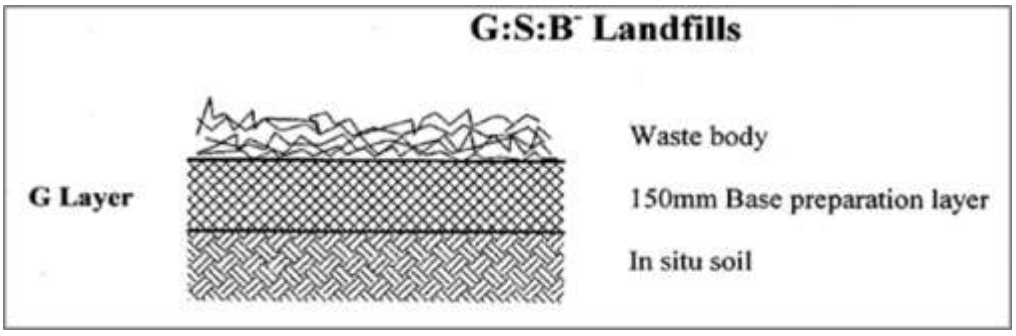

Figure 1 Construction design of general waste cell for a G:S:B^- landfill site

2. Legislation

The following legislation and policies are applicable to this assessment

Legislative Instrument	***Objective***
The Constitution of the Republic of Namibia	Sets the overall principle of sustainable utilization of natural resources and prevention of pollution.
The Environmental Management Act (No 7 of 2007) and its Regulations	Aims to regulate development activities to align with principles of sustainable development, where all impacts to the environment, people and economic outcomes are evaluated and appraised.
The Water Act (No. 54 of 1956) and the Water Resources Management Act (No. 11 of 2013)	The former remains relevant applicable legislation, with the WRM act yet implemented. The Acts control the use of groundwater resources and further afford protection of the resources from potential polluting activities.
Public and Environmental Health Act (No.1 Of 2015)	The act aims to protect public health from potential harmful activities.
National Solid Waste Management Strategy	The strategy aims to strengthen institutional and legal framework for management of solid waste serving as a guide to institutions such as local authorities on sound waste management practices.
Pollution Control and Waste Management Bill	Once passed as an Act it will serve to regulate and prevent the discharge of pollutants to air and water as well as providing for general waste management. However, it is necessary to proactively consider its requirements.

3. Baseline Description of Locality

3.1 Geology

3.1.1 Regional Geology

The Zambezi region is underlain by rocks of the Kalahari group formation with depth up to 150m beneath ground surface. Miller (2008) describes the Kalahari covering as varied in thickness across the region but may average around 216 m, established from water borehole logs southwest of Katima Mulilo. Moreover, older borehole logs show a succession of sand or clayey to sand/loam in various parts of the region, with some of the sand layers unconsolidated. The base of the Kalahari sand cover is marked by the presence of Karoo basalts, which are exposed at the rapids near Katima Mulilo, and near Ngoma to the east, however, more of these basaltic rocks are extensively exposed within the Island of Impalila (Miller, 2008).

3.1.2 Local Geology

Lithology of boreholes drilled in the surrounding area indicate the presence of alternative layers of sand, clay, and clayey-sand at shallow depth up to 20m and appearance of calcareous sand and sandstone at much deeper depth, typical of the Kalahari formation. The presence of clayey material in the local formation is an important lithological characteristic to the site and to the envisaged activity.

Figure 2 below provides a view of the nature of the material making up the subsurface of the landscape in the project area. The presence of several gravel mining burrow pits is testament of the extensive compaction of clay material from just below ground surface and expected to extend up to 11 to 12mbgl prior (observed from hand dug well depth from surface of the burrow pit).

Figure 2 Clay material underlying the top superficial material of sandy-loam soils

3.2 Hydrogeology

3.2.1 Regional Hydrogeology

The Kalahari Sequence is characterized as mainly of porous aquifers, however, displays variability in properties over short distances (Christelis and Struckmeier, 2001). A good yielding borehole may be followed or surrounded by low yielding boreholes in proximity. Moreover, groundwater levels are generally elevated or shallower towards river systems and deepens away, typically westwards with increasing topography (Christelis and Struckmeier, 2001).

3.2.2 Local Hydrogeology

Available information from old borehole records of the indicates the nearest borehole to the site is located some 1.6km northwest of the site, and other boreholes located even further of the first, northwards.

3.2.2.1 Groundwater levels

The water level information of these boreholes deepens northwards. The closest borehole to the project site indicates depth of over 20mbgl to the water table. The boreholes further northwards have depth to water level increasing up to 32mbgl at a distance of 4km from the site. Lohe et al. (eds, 2021) affirms the northward increase in the depth to water level towards the border with Zambia.

In contrast, boreholes located south of the site, some 3 km away and across the Trans-Caprivi Highway seem to indicate shallow levels, a trend that appears to proceed further eastwards to the town of Katima Mulilo, typical to find due to proximity to the Zambezi river (Figure 3).

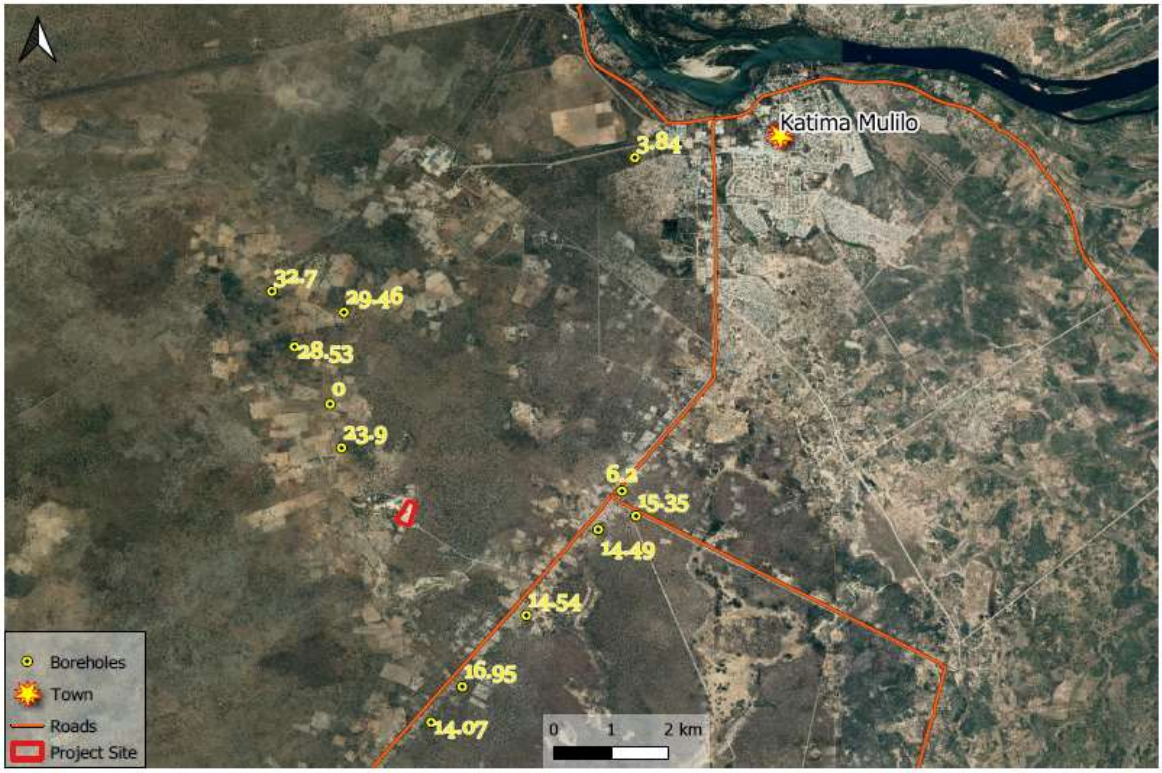

Figure 3 Depth to water level in boreholes

3.2.2.2 Borehole yields

The yields of boreholes are variable over short distances confirming the description by Christelis and Struckmeir (2001). The borehole yields range is 2 to 11 m^3/h observable in Figure 4. The observed yield information indicates good groundwater potential in the locality of Liselo and areas beyond.

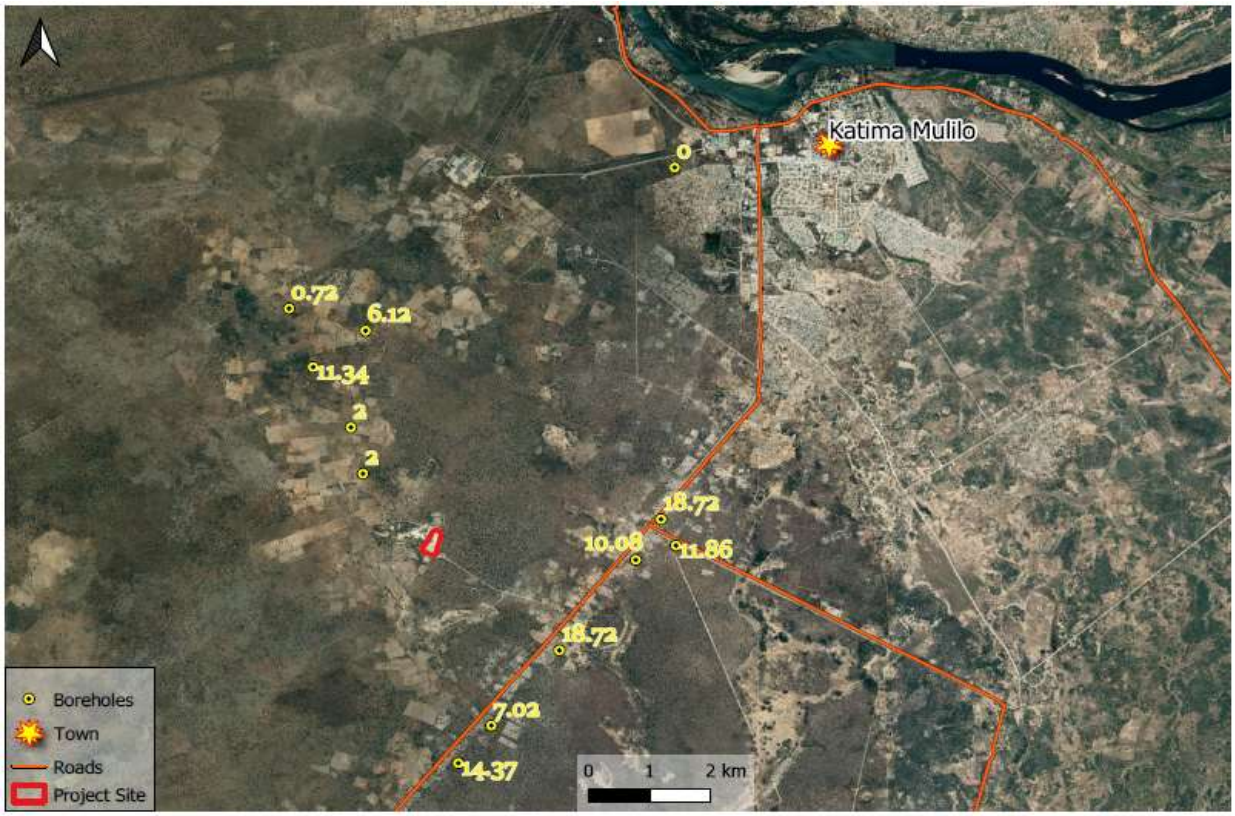

Figure 4 Borehole yields in the surroundings of the project site

3.3 Groundwater Flow Directions

Studies by the Margane et. al. (2005) points out that the groundwater flow direction is south to southeastwards of the region (Figure 5), accordingly to topographical decline towards the flood prone areas and watercourses. This assertion confirms the observed water level decline towards the south, south-east to east from the water levels of the old borehole information given in Figure 3. This implies that any water quality related deterioration from an impactful activity is likely to flow south to southeasterly. This area has a number of recently drilled boreholes but further secures it drinking water from the pipeline to Kongola with supplemental uses obtained from boreholes.

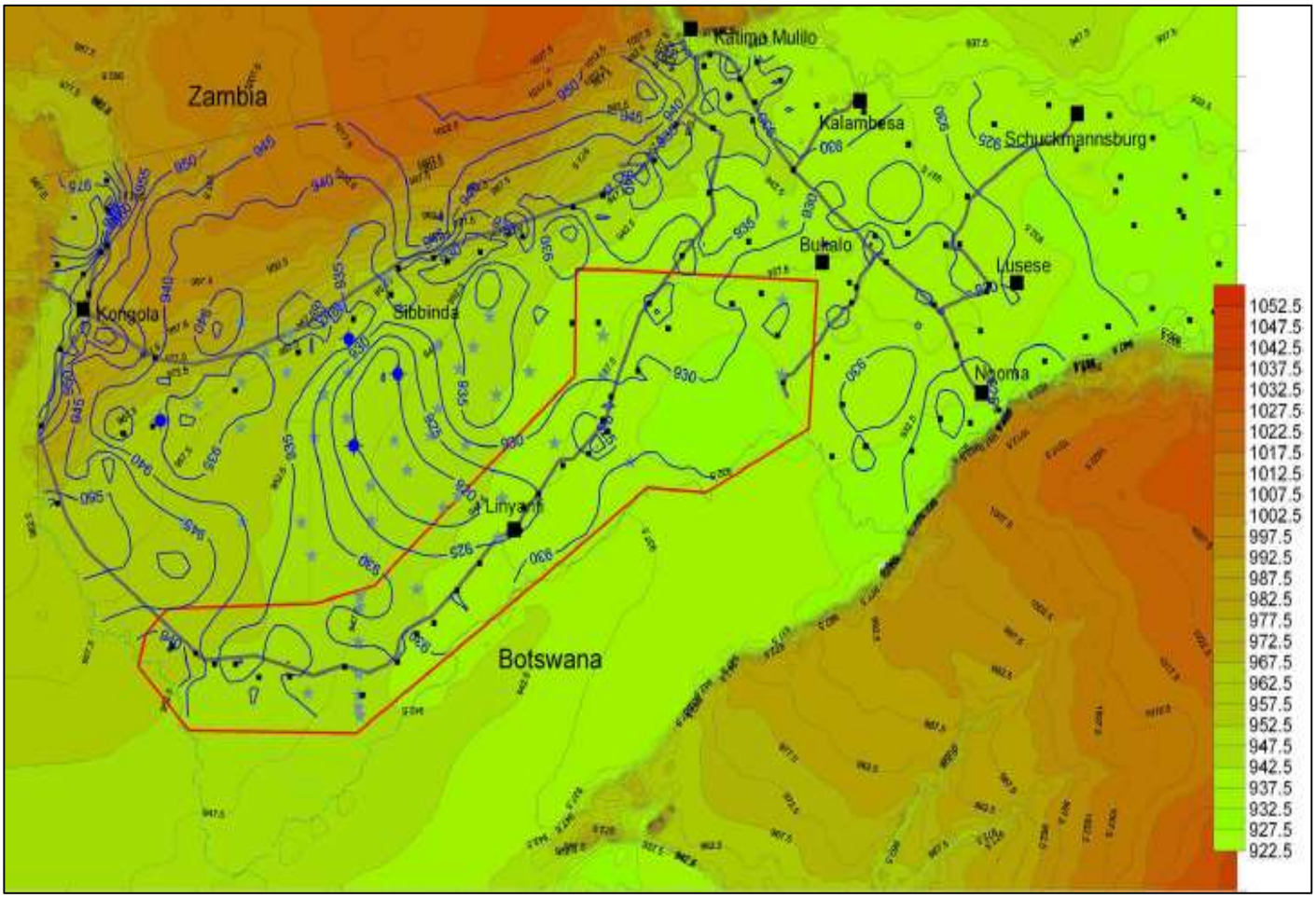

Figure 5 Water level contours (blue lines)

3.4 Hydrocensus Survey

Due to the limited and old nature of borehole data in the above description, it was necessary that a hydrocensus is carried out around the site to establish any recent data that can be used to corroborate or object the old borehole data. Therefore, a survey was carried out within 1km radius of the site to detect and collect any groundwater information for the assessment. The findings are listed in the table 1 below.

3.4.1 Hydrocensus Survey Findings

Table 1 Findings of the hydrocensus

Borehole ID	**Lat**	**Long**	**Water level (mbgl)**	**Source type**	**Distance from site**	**Status**	**Uses**
Burrow Pit Well	-17.56302	24.21906	2[+]	Hand dug well	Inside the pit	In use	Mainly livestock and some limited human consumption.
WP 1(WW 34624)	-17.55437	24.20694	-	Borehole	1.5km	In use	Domestic
WP 2(WW 47615)	-17.55845	24.22041	-	Borehole	760	In use	Domestic
WP 3&4	-17.57152	24.23145	18m*	Borehole	1.4km	In use	Horticulture irrigation
WP 5	-17.574310	24.228696	-	Borehole	1.35	In Use	Horticulture
[+] Water level is from burrow pit surface * water level is approximated.							

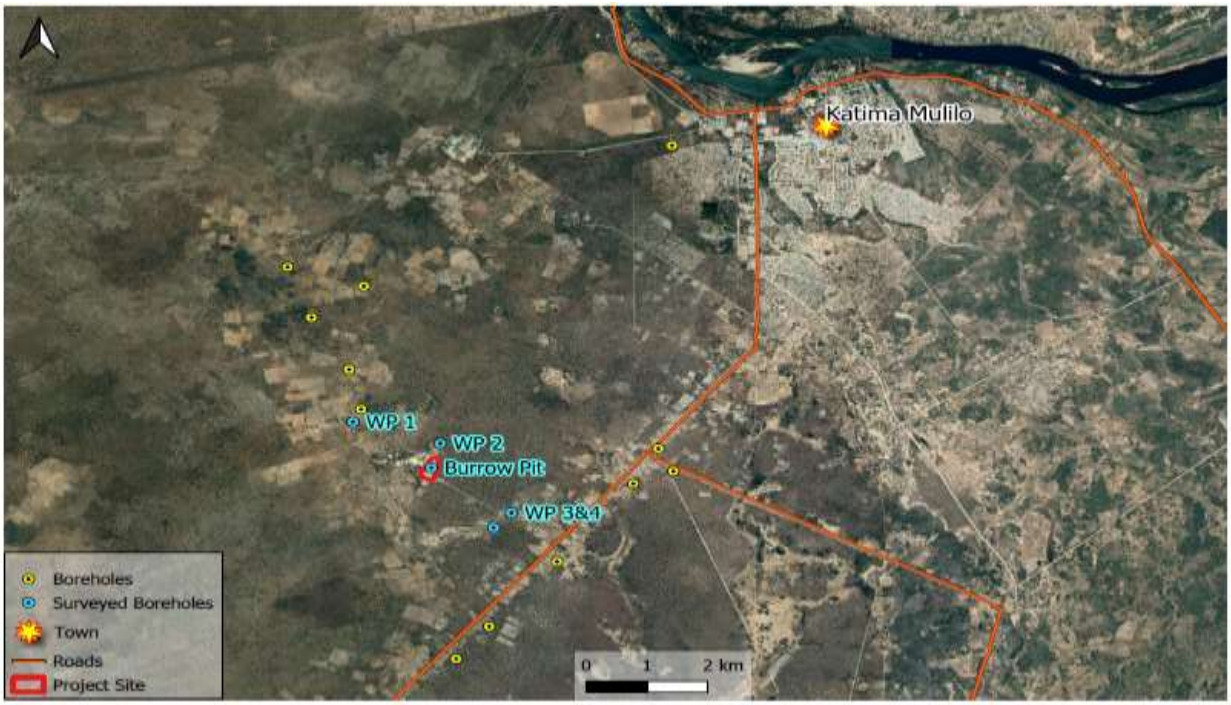

Figure 6 Surveyed water points (boreholes) in 1.5 km radius

Figure 7 Hand dug well in burrow pit

3.4.2 Interpretation of Findings

Limited details were obtainable of the actual depth to water level of the boreholes visited around the site, this is mainly due these being installed and thus not possible to insert water level measurement equipment's. However, indications are that around the site, depth to water level may reach up to 20mbgl.

The owner of Water Point 3&4 approximated depth to water level in his boreholes at around 18mbgl. These water points are located some 1.5km from the site and thus can be inferred as affirming the general elevating nature of water levels in a south to southeasterly direction and thus the groundwater flow direction.

The water in the hand dug well that appears occurs at a level approximated at about 10mbgl from the general landscape of the area and about 2 meters below the surface of the burrow can be understood to be of a perched nature and thus limited in extent, and the main aquifer at about 20mbgl. It can also be deduced from this information that the unsaturated zone is reduced by some 8m from the adjacent landscape surface due to the existence of the burrow and thus remaining a remaining distance of 12m to the water table.

This finding plays a critical role in ascertaining the risk from potential pollution of the main aquifer zone, as the layer of unsaturated zone above the main aquifer zone acts to attenuate contaminants. The further the distance from the surface or contaminant source to the main aquifer zone, the more effective the attenuation process, however subject to other factors. Therefore, maintenance of the current buffer overlaying layer is critical.

3.5 Groundwater Chemistry

3.5.1 Groundwater Quality

The hydrocensus team visited four sites that were easily reachable as provided in Table 1. Water samples were collected at three of the four sites that provided easier accessibility. These samples were collected to determine the general water quality of groundwater as baseline information in the area.

The burrow pit well is an exposed water source thus results of this sample need to consider the interactions of this source with the surroundings when interpreting the data. The second sample was from a hand pump installed borehole, thus collected after pumping for several minutes and similarly to a private well WP2 where the owners pumped a few minutes for sample collection. This is notable to mention as sampling protocols requires that borehole sampling is carried out after pumping of the borehole. Although the overall acceptable practice was not assured, this is of value to the process.

The collected samples were submitted for analysis of general water chemistry to the Analytical Laboratory Services in Windhoek. The results thereof are provided in table 2 below.

Table 2 Water quality results of samples from the burrow pit and surrounding area

	Burrow Pit Well	WP 1	WP 2	Group A	Group B	Group C	Group D
Ca	54	1	1.1	150	200	400	1000
Mg	15	0.4	0.2	70	100	200	500
Na	5	298	205	100	400	800	2000
K	3.5	4.5	3.4	200	400	800	
Fe	0.21	0.8	0.04	0.1	1	2	10
F	1.1	1.9	0.6	1.5	2	3	2-6
NO_2	<0.5	<0.5	<0.5	10	20	40	100
NO_3	0.04	<0.01	<0.01				10
Mn	0.03	<0.01	<0.01	0.05	1	2	10
Cl	3	3	6	250	600	1200	2000
SO4	3	10	2	200	600	1200	1000
TDS	193	691	473				6000
pH	7.4	8.8	9.4	6-9	5.5-9.5	4-11	
EC	35.5	114.1	473	150	300	400	

3.5.2 Interpretation of Water Quality Data

The results of the samples collected at the water points indicate that the overall quality of the water is of drinking quality (Group A) premised on the Water quality guidelines of the DWA of the MAWLR. It is notable that WP 2 closer to the burrow pit has a high electrical conductivity (EC) relative to the other samples. Further notable is that samples of WP 1 and WP 2 are relatively similar in chemistry to that from the burrow pit well an indication that they could be taping different sources as earlier assumed but also keeping in mind that the

latter source is exposed and thus other factors may interact and influence the quality such as livestock coming closer to the water point. Nonetheless, the Burrow Pit water is attributed to a shallow perched aquifer above the Kalahari aquifer that seats at about 20mbgl.

3.6 Groundwater Usage

The majority of the communities of the area rely on the Katima - Kongola pipeline as a source of water for domestic needs. The findings of the hydrocensus indicate that there is limited reliance on groundwater in the surroundings, except for outposts near crop fields which rely on hand pump installed boreholes serving mainly livestock drinking and for some human consumption specifically those tending to the seasonal cultivation of crop fields or tending to livestock. Figure 8 below indicates the nature of the installation at WP1 located some 1.4km northwest of the project site.

Figure 8 Hand pump water point in surrounding area

Boreholes located on the way from the site towards the main highway were described as mostly used for gardening purposes although some domestic needs are also met from them.

3.7 Conceptual Model of Envisaged Landfilling

A Conceptual model of the envisaged landfilling at the acquired site is given in Figure 9 below. It is important to take note of the importance of base layering under the cell, and the unsaturated zone from the base the waste cell to the aquifer zone. The base layering is

envisaged as clay material abundant in the burrow pit and compacted to design standard as prescribed in earlier sections.

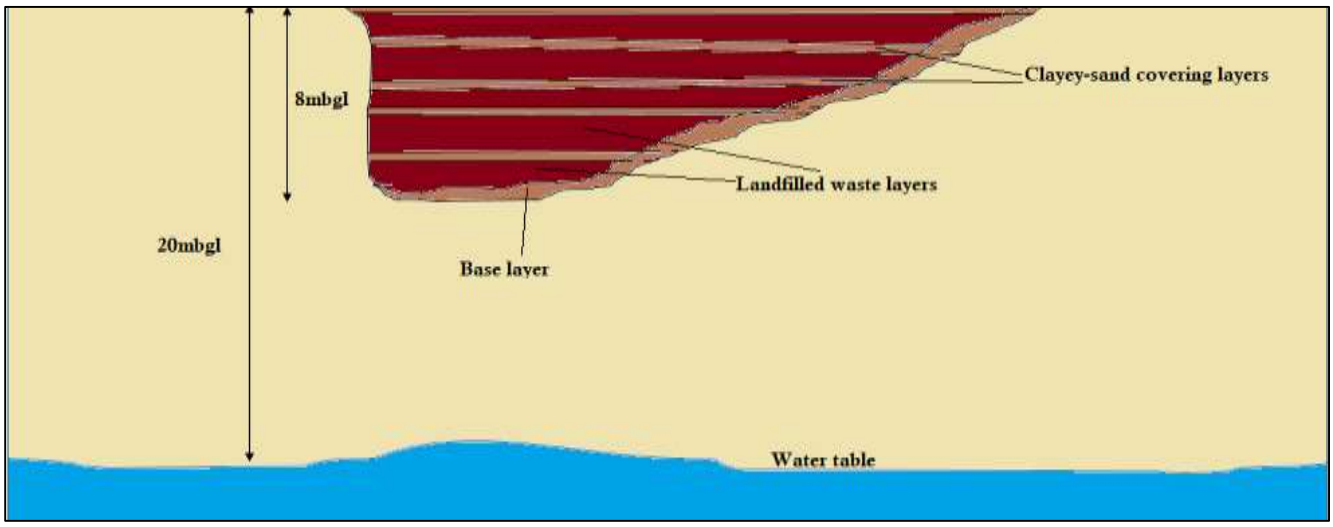

Figure 9 Conceptual view of the envisaged landfilling of the acquired burrow pit

4. Impact Assessment

In order to assess and understand the potential environmental risk posed on local groundwater resources a standard impact assessment methodology will be utilized so that a wide range of potential impacts can be compared.

The following significance rating method will be used to rate impacts emanating from the proposed landfill site activities where each category will be assigned points. These points will be computed by using the equation below and each potential impact will be assigned an impact significance rating (IS).

Therefore: **IS= (IE+ID+IM) * IP**

Parameter	**Character**	**Description**	**Code**
Impacts Nature (IN)	Adverse	Impact has negative impact	-
	Beneficial	Impact has potential benefit	+
	Neutral	Neither adverse or beneficial	0
Impact Probability (IP)	None	Will never occur	0
	Improbable	In exceptional cases	1

	Probable	Could occur at some point	2
	Likely	Might occur	3
	Highly likely	Expected to occur	4
	Certain	Will occur	5
Impact Extent (IE)	Project site	Limited to the project site	1
	Local	Beyond the boundary of the project site	2
	Constituency	Beyond local surroundings over 10km away	3
	Regional	Over 50 to 100km	4
	National	extend to other regions and or beyond the border	5
Impact Magnitude (IM)	No effect	None	0
	Negligible	Limited damage to minimal area. Restricted to the project site and immediate surrounding	4
	Moderate	Short term impacts but not affecting the ecosystem or community functioning, may be rehabilitated in a very short time	6
	High	Very serious long term impacts impairing ecosystem or population functioning. May take a lifetime to recover.	8
	Very High	Irreparable damage	10
Impact Duration	Immediate	less than one year	1
	Short term	between one year & five years	2
	Medium Term	between five years & 15 years	3
	Long term	impact ceases after operational life span of the project	4
	Permanent	Impacts lasts a human lifetime	5

The significance ratings below will determine the action required on each impact.

Scale	**Significance level**	**Abbrev**	**Description**
IS < 25	Not significant	NS	The impact is not substantial and does not require any mitigation action.

25> IS <48	Low significance	LS	Some minimal measures or monitoring may be required for this activity
48> IS <60	Moderate Significance	MS	Mitigation measures required
IS <75	Highly Significance	HS	Mitigation Critical, project may not go ahead

4.1 Description of Impacts Envisaged

4.1.1 Preconstruction phase

- The relevant activity in this phase to this assessment is the planning of the site layout to consider the location of the hand dug well located in the burrow pit. This location is a weak point in the burrow pit surface relative to adjacent surfaces and thus cannot be included as part of landfilling cells. The entire surface of the burrow and sidewalls are of hardened clay surfaces. However due to the digging of the well, the point of the well penetrated the intact clay layer into sandy material that hosts the perched aquifer in the well. This area has been avoided and will be used as to construct an evaporation pond, to retain water flows within the burrow in rainy times.

4.1.2 Construction phase

- The construction activities will involve the use of earth moving machinery that require servicing using lubricants and parts thus generation of waste.
- Generation of wastewater = the presence of workers requires that ablution facilities be established onsite, these will generate effluent that requires handling and treatment in some form.
- Accidental spill of fuels and oils – this can result from refueling of the machines or breakdown on the machines and thus leakage to the ground and further infiltration.

4.1.3 Operation Phase

- The operational activities will involve the use of earth moving machinery that require servicing using lubricants and parts thus generation of waste.
- Sanitation facilities used by the onsite workers will produce effluent that requires treatment and disposal

- There is a potential for generation of leachate from landfilled waste infiltration and reaching the saturated zone.

4.1.4 Decommission phase

- Landscaping works will involve use of earth moving machines and this further presents the potential risk of groundwater pollution from spills of fuel or oils from refueling or accidental break of pipes or fuel tank.
- Leaching from landfilled material has a potential for pollution of groundwater resources post the lifespan of the site.

4.2 Impact Significance Assessment

Activity	Action	Impact	IN	IP	IE	IM	ID	IS
Construction Phase								
	Fueling and use of earth moving machines	Accidental leakage or spill of oils/fuels onto soils/groundwater	-	c	2	8	3	**65**
	Ablution facilities onsite of wastewater from ablution facilities	Generate wastewater with potential seepage into subsurface and pollution of water	-	4	2	6	1	**52**
Operation Phase								
	Fueling and use of earth moving machines	Accidental spillage of oils or fuels infiltrating to groundwater	-	5	2	8	3	**65**
	Landfilling of high moisture content waste	Leachate generation to subsurface environment	-	5	2	8	4	**70**
	Generation of wastewater from ablution facilities	Pollution of groundwater from seepage of the wastewater to the subsurface	-	4	2	6	1	**52**
Decommissioning Phase								
Final earthworks	Cleaning and landscaping the area	Accidental spillage of oils or fuels infiltrating to groundwater	-	5	2	8	3	**65**
	Onsite ablution facilities	Potential pollution of groundwater from wastewater seepage into subsurface	-	4	2	6	1	**52**
Site closure and aftercare	Potential leaching of landfilled material	Potential pollution of groundwater seepage into subsurface	-	3	2	8	5	**45**

5. Environmental Management Program

Aspect/Impact	Objective	Controls	Performance Indicator	Monitoring requirement	Responsible	Applicable Phase
Accidental leakage or spill of oils/fuels onto soils/groundwater from moving machines onsite	Protection of groundwater from potential pollution	○ Daily inspection of machines for signs of leaks or spills and record findings ○ All refueling activities be monitored by site supervisor. ○ Provide drip trays onsite for use on detection of leaks or spillages.	Inspection records Staff awareness of the spill or leakage handling procedure Drip trays available onsite	Weekly inspection of records Monitoring of fueling times (days) Daily inspections of machines	Site Manager	All Phases to site
Potential pollution of groundwater from wastewater generated		○ Use of mobile ablution facilities in the initial phase of construction. ○ All wastewater generated to be pumped and transported to town/wastewater	Availability of mobile ablution facilities onsite during construction Constructed septic tanks for onsite structures Designated contractor for pumping of wastewater from septic tanks Septic pumping schedule	Weekly inspections	Site Manager and ECO	All phases

		treatment facility for proper handling and disposal.				
Potential pollution of groundwater from leachate generated		○ The base of the general waste cell adheres to the design specifications provided for type of landfill site classified. ○ Drilling of boreholes on up and down gradient of the site for water quality monitoring. ○ Include private water points (WP2, WP3 and WP5) in sampling for water quality and testing. ○ Analyze information and report any changes in water quality parameters	General waste cell base layered as per recommended design. Monitoring boreholes drilled as specified. Water quality sampling plan	Quarterly sampling and testing of water samples. Quarterly reporting of results Bi-annual reports	PR/ ECO	Operation and Decommissioning

6. Conclusions and Recommendation

The most significant risk of the envisaged activities is pollution of groundwater resulting from possible generation of leachate from the landfilled material. The assessment of the characteristic parameters of the site for classification indicates that leachate will be produced however sporadically based on climate. Materials such as food waste form part of the waste landfilled, this entails waste with high moisture content and thus potential to increase potential production of leachate. Nonetheless, should the recommended base design be implemented, this has potential to retain leachate produced from landfilling. Moreover, the unsaturated zone although reduced remains a critical factor in the attenuation of any leachate produced, and with an overlaying layer of 12m to the expected saturated zone, this provides some additional protection to pollution of the groundwater of the area.

A sustained groundwater monitoring regime from the new drilled boreholes and from the surroundings of the site is a prerequisite for implementation of the envisaged activity. Therefore, Implementation of the recommended mitigation measures is highly recommended towards the identified risks.

The EAP therefore recommend that this project may go ahead, on basis of implementing the environmental management program. The risks to the environment exists however the proposed measures are considered adequate to minimize the risks to levels less averse to the environment and surrounding communities.

References

Christelis, G. & Struckmeier, W. (2001): Groundwater in Namibia - an Explanation to the Hydrogeological Map.

Department of Water Affairs and Forestry's (South Africa) Minimum Requirements for Waste Disposal by Landfill, 2nd Edition (1998)

Lohe, C, Amster, R and Swartz, B (Eds). 2021. Groundwater in Namibia - an Explanation to the Hydrogeological Map.

Margane, A., Baeumle, R., Schildknecht, F. and Wierenga, A. 2005. Groundwater Investigations in the Eastern Caprivi Region. (Main Hydrogeological Report) *Investigation of Groundwater Resources and Airborne-Geophysical Investigation of Selected Mineral Targets in Namibia*, Volume IV.GW.2.1

Miller. R. MG. 2008. Geological of Namibia. Geological Survey of Namibia. Ministry of Mines and Energy, Windhoek, Namibia

Ministry of land Reform. 2015. Baseline Report (Volume 1) for the Zambezi Integrated Regional Land-use Plan

Annexures

B.1 Water Quality Guidelines (DWA-MAWLR)
B.2 Envisaged Drilling Areas

THE WATER ACT, 1956 (ACT 54 OF 1956) AND ITS REQUIREMENTS IN TERMS OF WATER SUPPLIES FOR DRINKING WATER AND FOR WASTE WATER TREATMENT AND DISCHARGE INTO THE ENVIRONMENT

1. INTRODUCTION

The provisions of the Water Act are intended, amongst other things, to promote the maximum beneficial use of the country's water supplies and to safeguard water supplies from avoidable pollution.

The drinking water guidelines are not standards as no publication in the Government Gazette of Namibia exists to that effect. However the Cabinet of the Transitional Government for National Unity adopted the existing South African Guidelines (461/85) and the guidelines took effect from 1April 1988 under the signature of the then Secretary for Water Affairs.

The sections of the Water Act that relate to the discharge of industrial effluents are:
- Section 21(1) which states that
-- The purification of waste water shall form an integral part of water usage and
-- that purified effluents shall comply with the General Standard Quality restrictions as laid out in Government Gazette R553 of 5 April 1962 and
- Section 21(2) which further stipulate that this purified effluent be returned as close as possible to the point of abstraction of the original water.
Where a local authority has undertaken the duty of disposing of all effluents from an industrial process the provisions of Section 21(1) and 21(2) apply to the local authority and not the producer of the effluents. If there is difficulty in complying with these provisions then the applicant may apply for an exemption from the conditions in terms of Section 21(5) and 22(2) of the Water Act. The Permanent Secretary after consultation with the Minister may grant the issuance of a Waste Water Discharge Permit under Sections 21(5) and 22(2) subject to such conditions as he may deem fit to impose.

After independence, the Government of the Republic of Namibia decided that for the interim the existing guidelines will continue to be valid and to remain in use until a proper study has been conducted and new standards have been formulated (Article 140 of Act 1 of 1990).

2. GUIDELINES FOR THE EVALUATION OF DRINKING-WATER QUALITY FOR HUMAN CONSUMPTION WITH REGARD TO CHEMICAL, PHYSICAL AND BACTERIOLOGICAL QUALITY

Water supplied for human consumption must comply with the officially approved guidelines for drinking-water quality. For practical reasons the approved guidelines have been divided into three basic groups of determinants, namely:

- Determinants with aesthetic / physical implications: TABLE 1.
- Inorganic determinants: TABLE 2.
- Bacteriological determinants: TABLE 3.

2.1 CLASSIFICATION OF WATER QUALITY

The concentration of and limits for the aesthetic, physical and inorganic determinants define the group into which water will be classified. See TABLES 1 and 2 for these limits. The water quality has been grouped into 4 quality classes:

- Group A: Water with an excellent quality
- Group B: Water with acceptable quality
- Group C: Water with low health risk
- Group D: Water with a high health risk, or water unsuitable for human consumption.

Water should ideally be of excellent quality (Group A) or acceptable quality (Group B), however in practice many of the determinants may fall outside the limits for these groups.
If water is classified as having a low health risk (Group C), attention should be given to this problem, although the situation is often not critical as yet.
If water is classified as having a higher health risk (Group D), urgent and immediate attention should be given to this matter.

Since the limits are defined on the basis of average lifelong consumption, short-term exposure to determinants exceeding their limits is not necessarily critical, but in the case of toxic substances, such as cyanide, remedial measures should immediately be taken.

The overall quality group, into which water is classified, is determined by the determinant that complies the least with the guidelines for the quality of drinking water.

TABLE 1: DETERMINANTS WITH AESTHETIC / PHYSICAL IMPLICATIONS

DETERMINANTS	UNITS*	LIMITS FOR GROUPS			
		A	B	C	D**
Colour	mg/l Pt***	20			
Conductivity	mS/m !at 25 °C	150	300	400	400
Total hardness	mg/l $CaCO_3$	300	650	1300	1300
Turbidity	N.T.U****	1	5	10	10
Chloride	mg/l Cl	250	600	1200	1200
Chlorine (free)	mg/l Cl	0,1- 5,0	0,1 – 5,0	0,1 – 5,0	5,0
Fluoride	mg/l F	1,5	2,0	3,0	3,0
Sulphate	mg/l SO_4	200	600	1200	1200
Copper	µg/l Cu	500	1000	2000	2000
Nitrate	mg/l N	10	20	40	40
Hydrogen Sulphide	µg/l H_2S	100	300	600	600
Iron	µg/l Fe	100	1000	2000	2000
Manganese	µg/l Mn	50	1000	2000	2000
Zink	mg/l Zn	1	5	10	10
pH****	pH-unit	6,0 – 9,0	5,5 – 9,5	4,0 – 11,0	4,0 – 11,0

* In this and all following tables “l” (lower case L in ARIAL) is used to denote dm^3 or litre
** All values greater than the figure indicated.
*** Pt = Platinum Units
**** Nephelometric Turbidity Units
***** The pH limits of each group exclude the limits of the previous group

TABLE 2: INORGANIC DETERMINANTS

DETERMINANTS	UNITS	LIMITS FOR GROUPS			
		A	B	C	D*
Aluminium	µg/l Al	150	500	1000	1000
Ammonia	mg/l N	1	2	4	4
Antimonia	µg/l Sb	50	100	200	200
Arsenic	µg/l As	100	300	600	600
Barium	µg/l Ba	500	1000	2000	2000
Beryllium	µg/l Be	2	5	10	10
Bismuth	µg/l Bi	250	500	1000	1000
Boron	µg/l B	500	2000	4000	4000
Bromine	µg/l Br	1000	3000	6000	6000
Cadmium	µg/l Cd	10	20	40	40
Calcium	mg/l Ca	150	200	400	400
Calcium	mg/l $CaCO_3$	375	500	1000	1000
Cerium	µg/l Ce	1000	2000	4000	4000
Chromium	µg/l Cr	100	200	400	400
Cobalt	µg/l Co	250	500	1000	1000
Cyanide (free)	µg/l CN	200	300	600	600
Gold	µg/l Au	2	5	10	10
Iodine	µg/l I	500	1000	2000	2000
Lead	µg/l Pb	50	100	200	200
Lithium	µg/l Li	2500	5000	10000	10000
Magnesium	mg/l Mg	70	100	200	200
Magnesium	mg/l $CaCO_3$	290	420	840	840
Mercury	µg/l Hg	5	10	20	20
Molybdenum	µg/l Mo	50	100	200	200
Nickel	µg/l Ni	250	500	1000	1000
Phosphate	mg/l P	1	See note below	See note below	See note below
Potassium	mg/l K	200	400	800	800
Selenium	µg/l Se	20	50	100	100
Silver	µg/l Ag	20	50	100	100
Sodium	mg/l Na	100	400	800	800
Tellurium	µg/l Te	2	5	10	10
Thallium	µg/l Tl	5	10	20	20
Tin	µg/l Sn	100	200	400	400
Titanium	µg/l Ti	100	500	1000	1000
Tungsten	µg/l W	100	500	1000	1000
Uranium	µg/l U	1000	4000	8000	8000
Vanadium	µg/l V	250	500	1000	1000

* All values greater than the figure indicated.

Note FOR Table 2 on phosphate: Phospates are not toxic and essential for all life-forms. Natural water will, however, seldom contain phosphate; it is generally seen as an indicator of pollution and is usually accompanied by other pollutants. Wherever drinking water is combined with or consists wholly of reclaimed or recycled water, it may be expected to contain phosphate. The general guideline for a concentration level to be aimed at is 1 mg/l as P. But in many cases this may be difficult to achieve technically. For this reason the Department will allow a phosphate concentration level of up to 5 mg/l as P in water intended for human consumption. Please refer also to the "Note on Phosphate" under Section 3: General Standards for Waste/Effluent.

2.2 BACTERIOLOGICAL DETERMINANTS

The bacteriological quality of drinking water is also divided into four groups, namely:

- Group A: Water which is bacteriological very safe;
- Group B: Water which is bacteriological still suitable for human consumption;
- Group C: Water which is bacteriological risk for human consumption, which requires immediate action for rectification;
- Group D: Water, which is bacteriological unsuitable for human consumption.

TABLE 3: BACTERIOLOGICAL DETERMINANTS

DETERMINANTS	LIMITS FOR GROUPS			
	A**	B**	C	D*
Standard plate counts per 1 ml	100	1000	10000	10000
Total coliform counts per 100 ml	0	10	100	100
Faecal coliform counts per 100 ml	0	5	50	50
E. coli counts per 100 ml	0	0	10	10

* All values greater than the figure indicated.
** In 95% of the samples.

NB If the guidelines in group A are exceeded, a follow-up sample should be analysed as soon as possible.

2.3 FREQUENCY FOR BACTERIOLOGICAL ANALYSIS OF DRINKING-WATER SUPPLIES

The recommended frequency for bacteriological analysis of drinking water is given in Table 4.

TABLE 4: FREQUENCY FOR BACTERIOLOGICAL ANALYSIS

POPULATION SERVED	MINIMUM FREQUENCY OF SAMPLING
More than 100 000	Twice a week
50 000 – 100 000	Once a week
10 000 – 50 000	Once a month
Minimum analysis	Once every three months

3 GENERAL STANDARDS FOR WASTE / EFFLUENT WATER DISCHARGE INTO THE ENVIRONMENT

All applications in terms of Section 21(5) and 22(2), for compliance with the requirements of Section 21(1) and 21(2) of the Water Act (Act 54 of 1956) that purified water shall comply with the General Standard as laid out in Government Gazette Regulation R553 of 5 April 1962.

TABLE 5 GENERAL STANDARDS FOR ARTICLE 21 PERMITS (EFFLUENTS)

DETERMINANTS	MAXIMUM ALLOWABLE LEVELS
Arsenic	0,5 mg/l as As
Biological Oxygen Demand (BOD)	no value given
Boron	1,0 mg/l as B
Chemical Oxygen Demand (COD)	75 mg / l as O
Chlorine, residual	0,1 mg/l as Cl_2
Chromium, hexavalent	50 µg/l as Cr(VI)
Chromium, total	500 µg/l as Cr
Copper	1,0 mg/l as Cu
Cyanide	500 µg/l as CN
Oxygen, Dissolved (DO)	at least 75% saturation**
Detergents, Surfactants, Tensides	0,5 mg/l as MBAS – See also Note 2
Fats, Oil & Grease (FOG)	2,5 mg/l (!gravimetric method)
Fluoride	1,0 mg/l as F
Free & Saline Ammonia	10 mg/l as N
Lead	1,0 mg/l as Pb
Oxygen, Absorbed (OA)	10 mg / l as O*
pH	5,5 – 9,5
Phenolic Compounds	100 µg/l as phenol
Phosphate	1,0 mg/l as P - See also Note 1
Sodium	not more than 90 mg/l Na more than influent
Sulphide	1,0 mg/l as S
Temperature	35°C
Total Dissolved Solids (TDS)	not more than 500 mg /l more than influent
Total Suspended Solids (TSS)	25 mg/l
Typical faecal Coli.	no typical coli should be counted per 100 ml
Zinc	5,0 mg/l as Zn

* Also known as *Permanganate Value* (or *PV*).
** In Windhoek the saturation level is at approx. 9 mg/l O_2.

Note (1) on phosphate: Phospates are not toxic and essential for all life forms. Natural water will seldom contain phosphate; it is generally seen as an indicator of pollution and is usually accompanied by other pollutants. Wherever drinking water is combined with or consists wholly of reclaimed or recycled water, it may be expected to contain phosphate. There is no general guideline for phosphate contained in the Regulation 553. But generally it is assumed that eutrophication or algal bloom in dams is promoted by nutrient concentrations as low as 0,01 mg/l as P; generally a phosphate concentration limit for dams of 0,1 mg/l is recommended. All water that is consumed and subsequently discharged, will eventually end up in rivers, dams or

groundwater – that is why for potable water, a concentration level of 1 mg/l as P is aimed at.
But, again, in many cases of waste and effluent treatment, this may be difficult to achieve technically, or the required waste and effluent treatment infrastructure is not available; as the required infrastructure is sophisticated and expensive. The current situation calls for a compromise and for this reason, this Department will judge each application individually on its merits and allow, in certain cases, a phosphate concentration level of up to 15 mg/l as P in any effluent or waste stream to be discharged into the environment. This regulation is subject to be reviewed every two years, calculated from the date of approval of this document.

Note (2) on detergents, surfactants and ten sides: The MBAS (or methylene blue active substances) – test does not encompass all surface active compounds currently, commercially available. The limit given is therefore only a guideline. Many of the cleaning agents are toxic to biological life-forms in rivers and dams.
It should be taken into consideration that some commercial products interfere with the effective removal of oil, fat and grease by grease and fat traps, by breaking up such long-chain molecules into shorter ones. These cleaning agents thus effectively allow such components to pass through the traps and land into sections of a treatment plant further down the line and interfere with the process there.
Many cleaning agents contain very powerful disinfectants, and/or biocides. Such substances may interact with biological treatment processes. They may reduce the effectiveness of such treatment or 'kill' it completely, if they land in septic tanks, biofilters or even activate-sludge plants. Their activity may be attenuated by dilution.

4. AUTHORIZATION

Herewith, the Guidelines for the Evaluation of Drinking Water for Human Consumption with regard to Chemical, Physical and Bacteriological Quality, as well as the General Standards for Article 21* Permits, amended for detergents, surfactants, ten sides, as well as phosphates, are confirmed and remain in force until further notice.

Issued under my hand with the authority vested in my office, within the Ministry for Agriculture, Water and Rural Development,

PERMANENT SECRETARY
Dr V Shivute

WINDHOEK, **DATE STAMP**

Annexure B.2

Proposed Drill Sites for Monitoring Boreholes

Annexure G:

Proposed Perimeter Fence

Annexure J

Basic Septic Tank