

THE MUNICIPALITY OF WALVIS BAY LANDFILL SITE

**ENVIRONMENTAL AUDIT REPORT
FOR THE
RENEWAL OF THE ENVIRONMENTAL
CLEARANCE CERTIFICATE
FOR THE WALVIS BAY REFUSE LANDIFLL SITE**

April 2021

Document Control

Business Name	Municipality of Walvis Bay				
Project Title	Renewal of the environmental clearance certificate for the Walvis Bay Landfill Site				
Document Title	Environnemental Audit Report				
Document / Project No.	WBM REF – 12/1/5/3/7/3	Issue	1.0	Date	April 2021
Coordinated by	Nangula Amutenya – Amatsi				
Acknowledgement and Contributions by	David Uushona				
Authorizing Manager					
David DH Uushona				April 2021	
(Name)		(Signature)		(Date)	

Table of Contents

1	Introduction	1
2	ENvironmental audit report	1
2.1	Implementation of the LEMP	1
2.2	General Landfill Site Information	2
2.3	Compaction of waste and cover material	2
2.4	Contamination of Groundwater	3
2.5	Fauna, Flora and Natural Habitat	3
2.6	Sand Movement.....	3
2.7	Negative Impacts on Visual/Aesthetic Appearance of Desert.....	3
2.8	Impacts Related to Security and Access Control.....	4
2.9	Negative Impact Resulting from Odour	4
2.10	Impacts Related to Workers' Health and Safety	5
2.11	Landfill Site Rehabilitation and Closure.....	5
2.12	Site records and LEMP review process.....	5
2.13	Fencing of the landfill site.....	6
3	Conclusion	7
	Annexure A – ECC issued in May 2018	8
	Annexure B – Records of waste received over the past three years.....	9

1 INTRODUCTION

Walvis Bay Town form part of the regional authority of Erongo Region. As with other local authorities in Namibia, the waste disposal sites are entitled to effective management to ensure environmental sustainability. This is in accordance with the Environmental Act, 2007 and its regulations. As part of the process, in May 2018, the Municipality of Walvis Bay`s solid waste landfill site had acquired an environmental clearance certificate (ECC) after submitting a detailed landfill site environmental management plan (LEMP) (ECC attached as Annexure A). The LEMP made provisions for the environmental management of its activities and operations. In terms of Environmental Management Act, 2007, the site was declared as a waste disposal site through a government gazette on 1 November 2018.

The recommended management steps and activities within the LEMP were highlighted to provide guidance in the maintenance and achievement of a designated landfill site for the Town. The Walvis Bay landfill is a standard facility and classified as a G:M:B General Waste Site in terms of the 2nd Edition of the *South African Minimum Requirements for the Handling and Disposal of Hazardous Waste*.

The ECC is only valid for three years therefore in this regard, a renewal application is hereby submitted and a brief environmental performance audit report is documented in this report.

2 ENVIRONMENTAL AUDIT REPORT

This report provides a summary of progress in accordance with the overall objective of managing the current Walvis Bay landfill site in line with the approved LEMP.

The following are covered herewith:

2.1 Implementation of the LEMP

Management requirement action: The Municipality of Walvis Bay is solely entitled and required to ensure implementation and adherence to . Environmental Impact Assessment Regulations: Environmental Management Act, 2007..

Progress: The first application for the LEMP approval coupled with the Environmental Clearance Certification was acquired on the 08 May 2018. The entire Draft LEMP fulfils the minimum requirements in terms of clause 8(j) of the national Environmental Impact Assessment Regulations.

2.2 General Landfill Site Information

Management requirement action: The municipality to erect one upgraded/improved on weatherproof information notice board at the entrance.

Progress: The notice board has been erected as shown in the picture below.



Figure 1: Entrance notice board

2.3 Compaction of waste and cover material

Management requirement action: Daily compaction of waste and cover materials should be done to reduce the volume of waste, thereby increasing the life-span of waste disposal site.

Progress: Sufficient compaction is maintained with the earth-moving machinery used on the site.

2.4 Contamination of Groundwater

Management requirement action: Contamination through leachates could pollute the underlying ground water. Although not recommended in the *National Solid Waste Management Strategy for Namibia* the establishment of permanent (capped) groundwater monitoring boreholes, one up-gradient and one down-gradient on the groundwater flow, shall be investigated for feasibility and practically at the landfill site and hazardous waste cells. The boreholes will then be sampled on an ongoing basis.

Progress: No monitoring boreholes has been drilled yet, thus contamination of ground water is not being monitoring.

2.5 Fauna, Flora and Natural Habitat

Management requirement action: All access roads will destroy desert habitat proportional to the surface area.

Progress: The area of any construction and or operation is confined to the smallest possible space. Well defined, single access roads are established, maintained and used throughout.

2.6 Sand Movement

Management requirement action: Mitigate the effects of dune encroachment and wind-blown sand.

Progress: Implementation of dune management strategies such as leveling and gravel covering of areas.

2.7 Negative Impacts on Visual/Aesthetic Appearance of Desert

Management requirement action: Plastic and paper waste material dumped at the landfill site, should be controlled, to avoid them being dispersed by prevailing winds. Plastic bags and paper visually degrade the natural landscape when blown into the desert and onto roads, they should therefore be mitigated to avoid visual degradation of materials from the landfill site.

Progress: On this aspect, various activities are being conducted in order to minimise wind blown litter. Below are the highlight of the what is being done:

- Waste disposal trucks are equipped with suitable coverage (e.g. heavy netting) to avoid litter being blown into the desert during the transportation of waste from all the suburbs to the site.
- Recycling operations are facilitated on or closest to the landfill site.

- Waste is covered systematically immediately after being disposed and the recycled materials have been removed.
- The work face area is minimized.
- The operating work face area is predominantly north-facing to reduce exposure to the predominantly south/south-west winds.
- A wind-litter catch (approximately 1.5 m high and as wide as the working face area) is placed downwind (nothing the two predominant wind direction for windblown waste (e.g. plastics)).

2.8 Impacts Related to Security and Access Control

Management requirement action: To provide an adequate access control and security system. This would prevent unauthorized entry and reduce the risk of injury/ damage.

Progress: On this aspect, various activities are being conducted in order to reduce the risk of injury or damage. Below are the highlight of the what is being done:

- Waste pickers are not allowed on the hazardous cell area.
- Only authorized waste recyclers are allowed on the landfill site.
- 24 hours security has been established and a permit system instituted.
- Suitable signage to warn personnel and visitors of the potential dangers of the hazardous landfill site is elected and maintained.
- No vehicle is allowed to approach any earth moving equipment closer than 30 m without specifically being instructed so by the landfill site operator's staff of the earth moving equipment.

2.9 Negative Impact Resulting from Odour

Management requirement action: To minimise impacts resulting from pungent gases and different odours.

Progress: The following management actions is being done:

- Wet waste tranches are covered on a basis.
- the surface area of the work faces is minimised
- the exposure time of waste in the air is minimised
- special cells for odorous compounds with minimum exposure to wind is introduced
- Hazardous waste is treated before disposal
- Waste is covered on a daily basis.

2.10 Impacts Related to Workers' Health and Safety

Management requirement action: To reduce occupational health and safety risks at the waste landfill site.

Progress: The following management actions is being done:

- The various workers for the recycling companies are provided with adequate personal protective equipment and training them in the use of such and ensuring that the equipment is being applied where applicable as well as educating them regarding the risk involved in working with hazardous wastes they are exposed to.
- Suitable signage to warn personnel of the potential dangers of the hazardous landfill site has been erected.
- The work face is being covered with cover material and compacting on a daily basis to reduce vectors of diseases on both the general landfill and hazardous cell.
- The numbers of workers working on the work face is kept at minimum.
- Vectors of disease is being managed through regular spraying, dosing and baiting.

2.11 Landfill Site Rehabilitation and Closure

Management requirement action: After the landfill or a single landfill cell has reached its final capacity the waste should be covered first by an intermediate cover layer to prevent erosion by wind and water and to enhance aesthetic issues. After the closure this landfill is to be managed and controlled in order to avoid adverse effects on humans and the environment.

Progress: The management recommendations as provided within the approved management plan shall serve guidance. This involves taking into consideration the commitment to regular monitoring and maintenance of site and environment as it is the case during the operation phase.

2.12 Site records and LEMP review process

Management requirement action: In terms of Task 1.1.6: “*Set up monitoring and reporting systems*” of the National Solid Waste Management Strategy, a database system is a critical component of the LEMP as the management plan will refer to operational records and reports, design information and monitoring reports, shall become the site records for the Walvis Bay Landfill Site.

The review period for this landfill site's LEMP will be on an annual basis, however the main review period will be every three years to coincide with the validity period of the Environmental Clearance Certificate (ECC) or as otherwise specified in the ECC.

Progress: The daily incoming waste loads is being recorded at the weighbridge. The amount of waste recycled is also recorded and tabulated on a on a monthly basis. The amount and type of waste received for the past three years are presented in Annexure B of this report.

2.13 Fencing of the landfill site

Management requirement action: Fence the land fill site

Progress: The fencing of the landfill site is to be done in four phases. The following has been done regarding the construction of the fence.

- Phase 1 was 690m and was completed in March 2019. Phase 2 was 170m and was completed in September 2019. See Figure 2 below.
- About 1940m is still to be constructed
- The bid document is done and with Procurement Management Unit, it is expected that construction will start in June 2021. The schedule for the remainder of the fence is depicted in Figure 3 below.



Figure 2: Completed fence at the entrance of the landfill site, phase 1 and 2

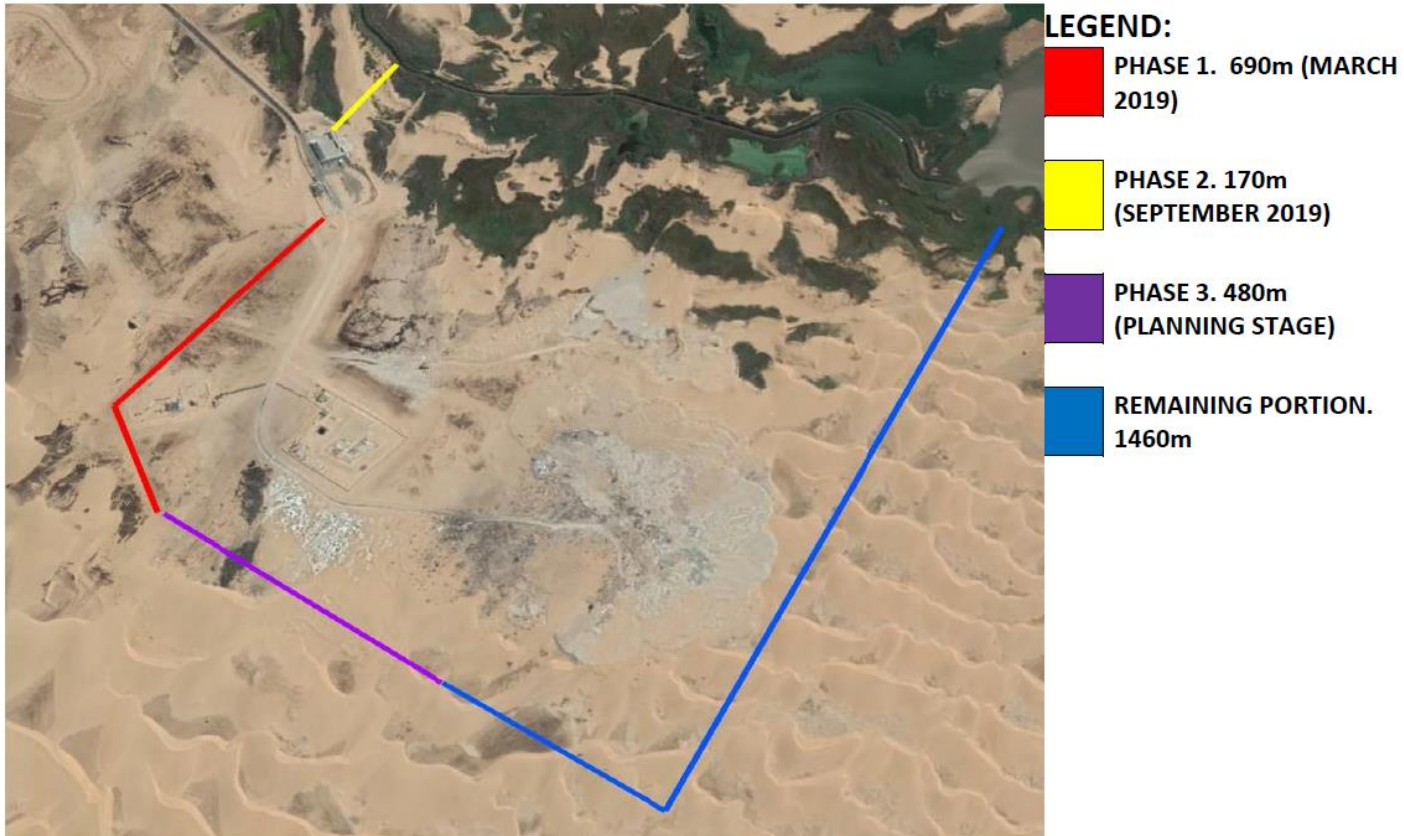


Figure 3: Construction phases of the landfill site fence

3 CONCLUSION

The Municipality of Walvis Bay shall ensure that progressive steps towards the achievement of the recommended actions in the LEMP are attained. This emphasis will be incorporated within the spheres of our organizational effectiveness of sustainability.

The Council is hopeful that the progress mentioned within this document presents our enthusiasm and responsibility for submission towards waste management requirements and adherence to the conditions of our ECC.

ANNEXURE A – ECC ISSUED IN MAY 2018

**ANNEXURE B – RECORDS OF WASTE RECEIVED OVER THE
PAST THREE YEARS.**



Municipality of Walvis Bay

Civic Centre · Nangolo Mbumba Drive · Private Bag 5017 · Walvis Bay · Namibia
Phone +264 (0)64 201 3111 · Fax +264 (0)64 204 528 · www.walvisbaycc.org.na

ANNEXURE B

RECORDS OF WASTE RECEIVED OVER THE PAST THREE YEARS.

2018/2019 - December 2020



SOLID WASTE CLEANING AND REMOVAL

General Cleaning Actions for 2020/21															
	18\19	19\20	20\21	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mch	Apr	May	Jun
*Contractor- Beaches	4005	3375	736	85	71	118	97	126	239						
*Contractor- Roads	3038	2858	617	81	76	72	84	55	249						
**KCC		17273	21601	3215	3241	3486	4349	3196	4114						
*** NCC		0	0	0	0	0		0	0						
SW Street cleaners	61279	35638	10559	1931	1856	1993	1538	1659	1582						
Total bags	68322	59144	33513	5312	5244	5669	6068	5036	6184	0	0	0	0	0	0
Dead dogs	177	232	29	7	7	2	6	3	4						
Notices	77	388	4	1	0	2	0	1	0						

Waste Removal and Transportation

COUNCIL REFUSE REMOVAL FOR 2020/21 (Weighbridge data in tonnes)															
	18\19	19\20	20\21	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Much	Apr	May	Jun
KM	6459	5943	3469	468	468	453	713	652	714						
LB	318	338	196	39	39	38	26	23	30						
Namport	972	1051	3824	666	677	577	560	614	730						
NDF	175	184	64	8	8	9	13	15	11						
NV	574	838	578	135	135	133	617	85	30						
WBPr	5429	5402	2180	388	388	396	367	319	321						
	13927	13756	10311	1705	1716	1606	1740	1708	1836	0	0	0	0	0	0



SOLID WASTE TREATMENT AND DISPOSAL

Waste Re-Use, Recycle & Recovering

Refuse Composition:

TOTAL WASTE AND TYPES ENTERING THE LANDFILL SITE (TONNES)															
	18\19	19\20	20\21	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mch	Apr	May	Jun
Black sand	61356	29175	16561	1340	1100	1558	834	3478	8252						
Boxes	231	231	101	16	16	12	13	16	27						
Building material	26251	14442	5576	755	755	947	1025	1691	399						
Burials	451	821	285	56	56	59	14	59	40						
Cans/Tins	12	22	1	0	0	0	0	1	0						
Car wrecks	27	45	36	12	3	2	11	8	1						
Condemn Food	42	19	2	0	0	1	0	0	0						
Domestic waste	12098	11583	6020	1038	1038	955	993	1014	982						
Garden refuse	3231	2717	1478	224	224	330	272	284	144						
Glass	16	20	11	2	2	3	0	3	1						
Industrial waste	21990	16758	58600	11480	11480	11269	10990	12152	1229						
Metals	3	62	1	0	0	0	0	0	1						
Oil	1182	492	3062	3	3	4	11	10	3032						
Other waste	1621	698	16	3	3	0	4	0	5						
Plastic/Paper	183	213	109	15	15	29	3	41	5						
Salt	3375	2755	3963	1242	1242	449	188	528	314						
Sewage	358	237	5	1	1	3	0	0	0						
Tyres	427	348	256	46	46	42	49	43	31						
Wood	129	207	34	3	3	8	4	11	6						
	132983	80845	96113	16236	15987	15671	14413	19337	14468	0	0	0	0	0	0



Waste Recycling on Landfill Site

- The recycling companies on the landfill site did very little recycling in the past few months due to the lockdown

WASTE RECYCLED (TONNES)															
	18\19	19\20	20\21	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mch	Apr	May	Jun
Carton	0	18	2	0	0	0	0	2	0						
Cans	53	21	21	4	6	6	7	0	5						
Glass	58	32	0	0	0	0	0	0	0						
Paper	0	13	0	0	0	0	0	0	0						
Plastic		119	25	0	0	0	2	23	0						
Steel	113	57	32	9	8	7	0	0	7						
	224	260	81	14	14	13	2	26	13	0	0	0	0	0	0



**THE MUNICIPALITY OF WALVIS
BAY LANDFILL SITE**

**DRAFT LANDFILL SITE
ENVIRONMENTAL MANAGEMENT PLAN**

FOR

THE MUNICIPALITY OF WALVIS BAY

APRIL 2018

Document Controls

Business Name	Municipality of Walvis Bay				
Project Title	THE MUNICIPALITY OF WALVIS BAY DRAFT LANFILL SITE ENVIRONMENTAL MANAGEMENT PLAN				
Document Title	Draft Landfill Site Environmental Management Plan (LEMP)				
Document / Project No.	WBM REF – 16/5/2/2	Issue	1.0	Date	April 2018
Coordinated by	David Uushona				
Acknowledgement and Contributions by	Riaan Archer – Hazardous Waste Inspector Peter Etsebeth – Foreman: Solid Waste Nangula Amatsi – Environmental Coordinator Lovisa Hailaula – Environmental Officer Peshito Shimweefeleni – Temporary Environmental Officer				
Authorizing Manager					
David DH Uushona				April 2018	
(Name)		(Signature)		(Date)	

TABLE OF CONTENTS

1. DESCRIPTION OF THE SITE	5
1.1. Site Location	5
1.2. Climate.....	6
1.3. Topography and Drainage.....	6
1.4. Geology and Soils	7
1.5. Geohydrology and Groundwater Qualities.....	7
2. LANDFILL SITE COMPONENTS/UNITS AND OPERATIONS	9
2.1. Entrance Component	9
2.1.1. Prefabricated Concrete Fencing	11
2.1.2. Gate House-Access Control	11
2.1.3. Information Notice Board.....	11
2.1.4. Administrative Building	11
2.1.5. Weighbridge and Control Room.....	11
2.1.6. Wash Bay.....	12
2.1.7. Incinerator	12
2.1.8. Public Disposal Unit.....	13
2.1.9. Stores and Garages	14
2.2. Hazardous Waste Disposal Component.....	14
2.2.1. Layout	15
2.2.2. Hazardous Waste Cell Design.....	15
2.2.3. Hazardous Waste Cell Drainage.....	15
2.2.4. Hazardous Waste Cell Leakage Detection and Pond	16
2.2.5. Hazardous Waste Site Operations.....	16
2.3. General Waste Landfill Component.....	18
2.3.1. Landfill Development	18
2.3.2. Recycling Stalls	18
2.3.3. Ablution	19
2.3.4. Operator's Yard	19
2.3.5. Gas Harvesting.....	19
2.3.6. Site Life	19
2.3.7. Operations.....	20
2.4. Civic Waste Facilities and Services	22
2.4.1. Security	22
2.4.2. Water Supply.....	22
2.4.3. Sewerage and Drainage.....	22
2.4.4. Electricity Supply	23
2.4.5. Housing of Employees.....	23
2.4.6. Roads and Parking Areas.....	23

3. MANAGEMENT AND REMEDIAL MEASURES	24
3.1. Introduction	24
3.2. Overriding Management Recommendations	24
3.2.1. General Landfill Site Information.....	24
3.2.2. Concerning Waste Management	25
3.2.3. Concerning Geohydrological Conditions.....	25
3.2.4. Concerning Biophysical Conditions	26
3.2.5. Concerning Social Factors:.....	26
3.3. Landfill Site Rehabilitation and Closure.....	28
4. SITE RECORDS AND LEMP REVIEW PROCESS.....	30
5. REFERENCES.....	31
ANNEXURE A: Incinerator Specs & Operations.....	32
ANNEXURE B: Landfill Site Operation & Control.....	34
ANNEXURE C: Landfill Site Audit Form.....	36

1. DESCRIPTION OF THE SITE

1.1. Site Location

The landfill site is situated 2 km to the south east of the town within the sand dunes, at the edge of the Walvis Bay town lands boundary covering a total area of 121.52 ha in size. The residential suburbs of Meersig and Walvis Bay Central lie 2 km to the west and northwest of the site respectively, and the suburb of Narraville lies 2.5 km to the northeast of the site, while the suburb of Kuisebmond is 3.5 km to the north of the site.



Map depicting the Walvis Bay Landfill Site in relation to the Town's Suburbs

The existing land-use is waste disposal at the existing waste site – for the past approximate 50 years, and open spaces in the surrounding dunes. All operations were initially under Municipal responsibility and operations were outsourced to private operators for the past 15 years. Access to the site used to be by means of a well-maintained gypsum gravel road from the town, which road was upgraded during 2011 - 2015 to a good quality tarred road. This road also provides access to the cemetery, the sewerage treatment works and the China Engineering Company (CHEC) reception area. Traffic on the road does not impact on any residential suburbs.

1.2. Climate

Walvis Bay is situated in the most arid part of the Namib Desert. The climate is characterized by mild summers and cool winters, with average minimum and maximum temperatures ranging between 10°C and 24°C. The cold water Benguela system along the coast has a moderating effect on the coastal climate.

Fog is a common occurrence in the central coastal Namib, often providing the only source of moisture. In spring and summer sea breezes move moisture inland, resulting in the formation of fog early and late in the day. In winter the fog is more the result of moist oceanic air blowing on shore.

Walvis Bay experiences small amounts of summer convective rainfall from the north and east, and winter frontal storms from the south. This results in highly variable, normally very low, seasonal rainfall in the area. The long term mean annual rainfall for Walvis Bay is less than 20 mm per annum, with annual totals ranging from 0 mm to 100 mm. Annual evaporation in the area is fairly high and evenly spread throughout the year. Although the evaporation is reduced by fog and low mean daily temperature range, the high mean wind speed increases the evaporation considerably. With minimal rainfall, most of the waste stream is expected to dry out, rather than decomposing.

Wind is an important environmental factor in the Walvis Bay area, particularly in the migration of sand dunes. There are predominantly two wind trends namely: (1) high velocity and high frequency south to southeasterly winds during the year but with extremes in September to December, and (2) high velocity and low frequency east to northeasterly winds predominantly during winter. Dust storms/sandstorms are common and not viewed as inclement weather. The high-speed winds present a particular problem for waste filling, resulting in extensive windblown litter and exposure of covered waste.

1.3. Topography and Drainage

The area of the site consists of shifting crescent shaped sand dunes up to 10 m high and depression at an elevation of about 1 m above sea level. The windward slopes of the dunes are fairly gentle whilst the leeward slopes tend to be steep, formed at the angle of repose of the loose sand. The orientation of the dunes reflects the high energy, unidirectional south-southwest wind regime with the migration of the dunes in a northerly direction with the long axis of the dunes thus perpendicular to the wind direction.

Apart from the fact that the site is located within the old delta of the Kuiseb River, there are no natural drainage features on and around the site. This is because of the absence of any significant rainfall and because of the Rooibank flood protection wall in the Kuiseb River. An artificial drainage feature has however been created by the liquid waste disposal wetlands to the north of the site. This wetland area is fed by treated sewage effluent and tends to produce a north westerly subsurface flow away from the waste disposal site. With the landfilling activities screened from the wetland by the present disposal site, no leachate formation is expected from the landfill area due to the intrusion of water from the wetland.

1.4. Geology and Soils

According to the 1:250 000 Geological Series Map, the area of the existing waste site is underlain at depth by granite and granodiorite bedrock of the Damara Sequence. This is overlain by aeolian sands with interactions of fluvial silts and occasional lenses of coarser grained fluvial sands and gravels. Because of its former deltaic activity, the sediments have been extensively reworked in a possible beach type environment, and overlying the sediments are numerous shifting dunes of aeolian sand.

1.5. Geohydrology and Groundwater Qualities

Saline water intrudes southwards as a wedge below the freshwater, which increase in thickness to the south. Groundwater north of the aquifer boundary, and therefore beneath the waste site, was found to be saline, although it is in hydraulic continuity with the Dorop North aquifer.

The groundwater gradient is fairly flat, and it is generally in a north-north-westerly direction away from the fresh water portion of the aquifer, and following the direction of the old Kuiseb River course. Treated sewage effluent from liquid waste disposal wetlands, however, contributes to recharge and produce a north westerly groundwater flow beneath the site. Any contamination from the waste site would therefore move away from the aquifer towards the sea.

Possible future abstraction from the Dorop North aquifer could reverse the ground water gradient towards the aquifer, although it is believed that the saline wedge would reach the abstraction wells before any contamination from the waste site. However, it would appear that abstraction of groundwater from the Dorop North aquifer is extremely unlikely on account of its poor water quality and since recharging of the aquifer appears to be inhibited due to the contaminants from the Rooibank flood protection wall in the Kuiseb River.

Although there does not appear to be any groundwater contamination from the waste site, the groundwater upstream of the waste site is saline (60% of salinity of seawater) in terms of water quality. The current area of operation has not had much of an impact on the groundwater, probably because of the slow migration (if at all) of contaminants from the waste body in the extremely arid climate.

A small amount of groundwater contamination from the older portion of the waste site has however occurred, mainly regarding ammonia and heavy metals such as iron, lead

and manganese. The magnitude of the contamination is such that the maximum limits of the SABS 241 Drinking Water Criteria have been exceeded. However, in view of the fact that the groundwater quality upstream of the site does not meet SABS 241 limits in terms of high salinity, and that the groundwater gradient is in a northerly direction towards the sea, the impact of this contamination is not considered to be significant, as it is highly impossible that the water may be exploited for the production of potable water.

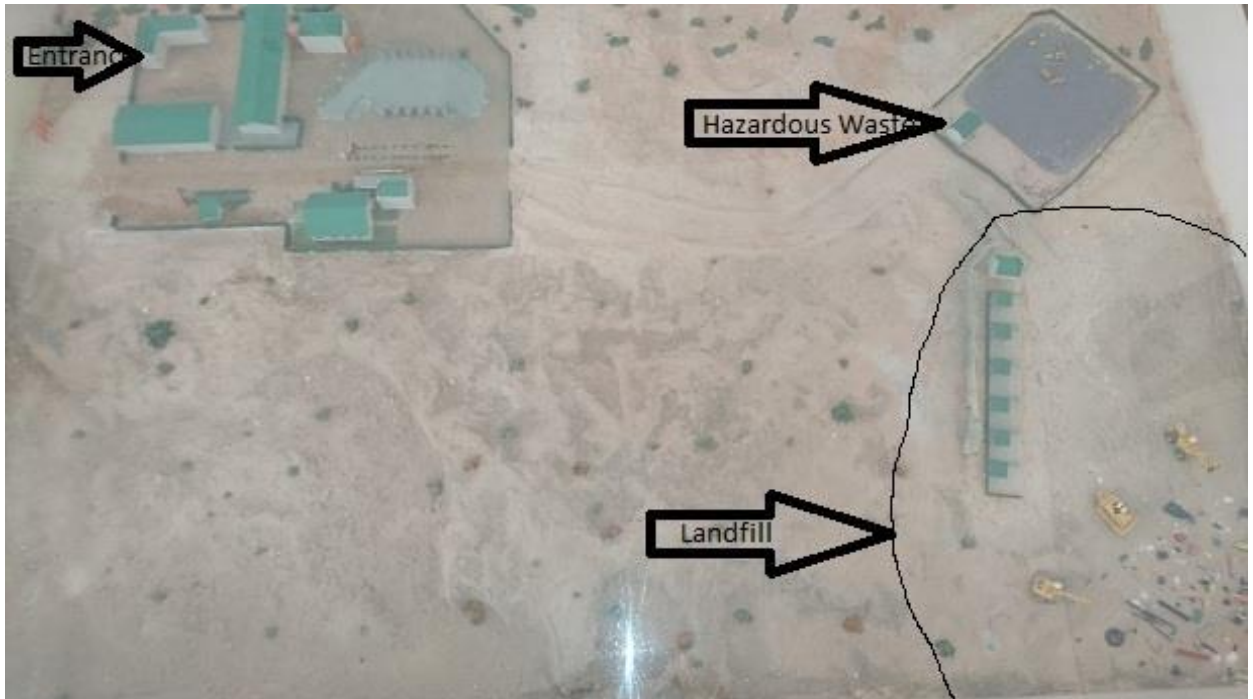
Notwithstanding the foregoing, the design of the extended site is such that the potential for groundwater pollution would be minimized. Apart from a fully lined containment cell for hazardous waste, the arrangement and operation of the waste disposal facility is directed at the minimization of possible contamination.

In the unlikely event that contamination of groundwater from the facility should occur as a result of liner failure, poor operation and etc., the effects of such contamination is not considered to be of extreme significance because of poor quality of the regional groundwater and its gradient away from the Dorop North aquifer towards the sea and the small volume of water involved due to the minimal rainfall in the area.

2. LANDFILL SITE COMPONENTS/UNITS AND OPERATIONS

The entire Walvis Bay Solid Waste Disposal Facility (WBSWDF) consist of three main components, namely:

- Entrance Component
- Hazardous Waste Disposal Component
- General Waste Landfill Component

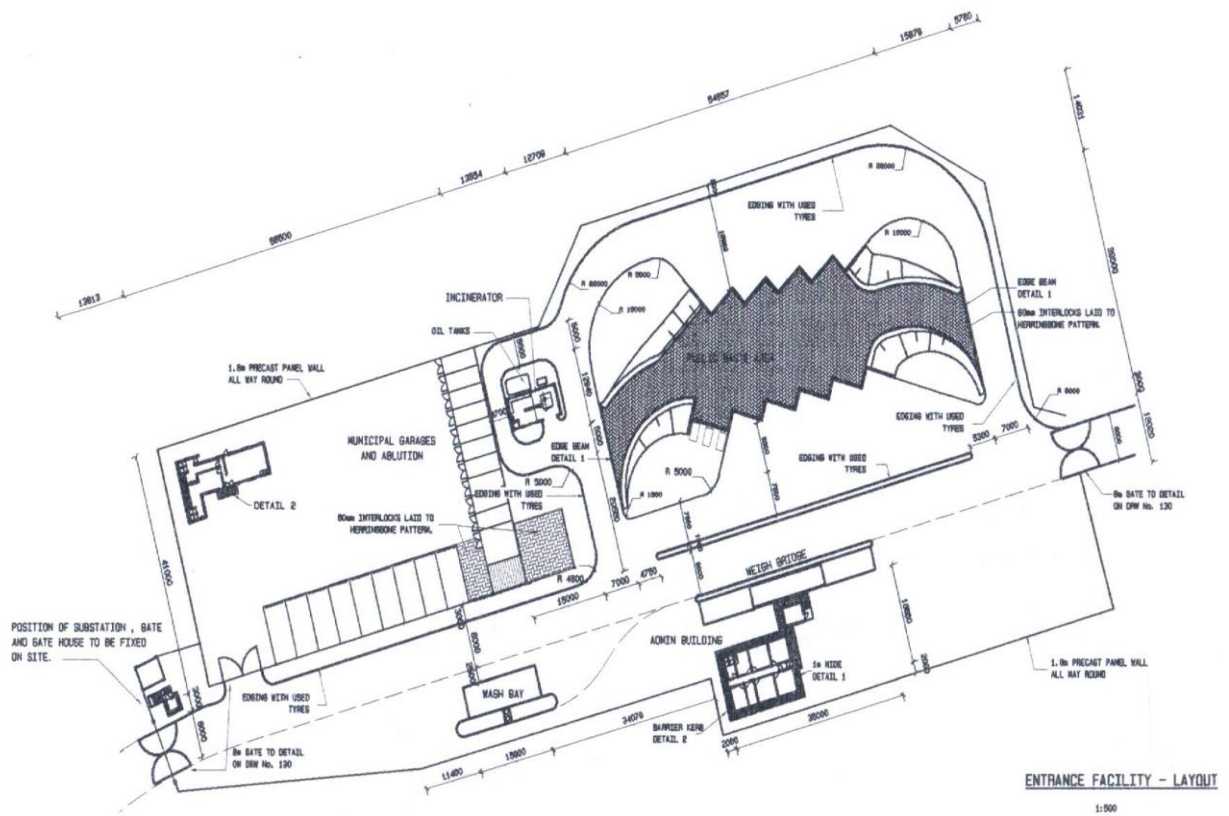


Model depicting the entire Walvis Bay Solid Waste Disposal Facility (WBSWDF)

Access to these components is by means of 8 m wide gypsum roads with appropriate signs.

2.1. Entrance Component

The entrance component of the WBSWDF is developed as a user friendly Public Disposal facility. It is fenced-off in prefabricated concrete fencing and provided with vehicle access gates at the entrance and exit of the component as depicted by the technical drawing below. The roads and area within the Entrance Component were initially provided with a gypsum gravel wearing course but entirely brick-paved late last year, 2017. As road drainage and kerbs are not required, road routes were initially also demarcated using old vehicle tyres but such tyres were replaced with concrete sleepers during 2011.



Technical Drawing of the Entrance Component

This area contains the following units:

- a) Access and Exit Gates and Prefabricated Concrete Fencing
- b) Electric Substation
- c) Entrance Control Gate-House with Control Boom
- d) Administrative Building
- e) Information Notice Board
- f) Weigh Bridge Control Room
- g) Weigh Bridge
- h) Wash Bay
- i) Incinerator with Workroom
- j) Public Disposal Unit with Facilities for Waste Sorting/ Separation/ Oil Reception
- k) Solid Waste Section Stores, consisting of:
 - o Ablution and Mess building, with Storage Lockers
 - o Garages for Small Vehicles
 - o Garages for Large Transport Vehicles/Compactor Trucks
 - o A Store for Equipment
 - o An Open Area Storage Area for Litter/ Refuse Bins
 - o An Under-roof Working Area with Paved Floor
- l) Potable water, Purified Effluent, Sewage disposal and Electric reticulation
- m) Road and Parking areas

2.1.1. Prefabricated Concrete Fencing

The Entrance Component is completely fenced-in with prefabricated concrete fencing, allowing access to the Entrance Component with a control gate at the western side and access to the rest of the Disposal Facility on the eastern side. The latter gate is locked after hours.

2.1.2. Gate House-Access Control

A permanent gate house is constructed at the entrance gate to facilitate control access of vehicles and people and to allow for the directing of vehicles to the appropriate disposal units. A concrete stairway is erected to the gate house to enable the gate guard to inspect the loads inside certain vehicles if deemed necessary.

2.1.3. Information Notice Board

An information notice board which displays information to the clients regarding the various operations and hours, details of operators, contact numbers, etc is provided next to the administrative building at the parking bay.

2.1.4. Administrative Building

The administration building includes four offices for the municipal solid and hazardous waste sections' senior staff members, a mess, ablution, and storage for protective gear and cleaning chemicals. The ablution is served with a small septic tank and soak-away.

2.1.5. Weighbridge and Control Room

The Weighbridge Control Room furnished with a desk, chairs, cabinets, printer and telephone is annexed/adjacent to the administrative building and is elevated overlooking the weigh bridge to facilitate viewing of trucks. The operations of the weighbridge are provided in the control room, which mainly include a computer for the recording of all types and quantity recording transactions.

The initial 15 m long above ground weighbridge was replaced late last year/2017 with an 18 m long weighbridge during a major refurbish and calibration exercise. This weighbridge is installed on the access road through the entrance component. Vehicles are regulated to pass over the weighbridge by means of computer linked traffic control signals installed at the weighbridge. The weighing mechanism is by means of an electronic load cell system provided with a computerized data capturing and processing system which is linked to the municipal computer network via a modem link with the appropriate software for the weighbridge control system and database. Three municipal weighbridge operators are sufficiently trained to operate the equipment, software and maintain the database. Should the computer controlling the weighbridge fail, the weighbridge operator is able to operate a manual system to maintain database by making estimates of the load in terms of both weigh and volume to maintain the database. In both cases the data is entered onto database manually when the facilities allow such.

All movements of materials, whether it be waste coming in or recovered material removed from the facility, are recorded as transactions. Incinerator's ash/residue is weighed before disposal in the Hazardous Disposal Unit. All materials moved from the Public Disposal Unit are also weighed prior to being disposed or recycled. Those that deliver waste (driver and assistant) stay inside the vehicle while it is being weighed, both on delivery and when departing, to ensure correct weight determination. The weighbridge operator maintains a complete inventory of the waste stream, stating the following information in each transaction:

- ✓ Name of weighbridge operator in attendance
- ✓ Date
- ✓ Time in
- ✓ Time out
- ✓ Vehicle registration
- ✓ Name source of waste
- ✓ Volume/mass- More than one container can be delivered on a vehicle
- ✓ Types of waste
- ✓ Disposal allocation

In addition, monthly summarise of the records are made and divided into the following categories:

- Number of loads
- Volume/mass
- Type of Waste
- Source of waste

Once waste end up on the landfill site no one is permitted to remove such waste as it became the property of the municipality of Walvis Bay.

2.1.6. Wash Bay

The vehicle wash bay for washing waste delivery vehicles is constructed adjacent to the outgoing lane of the access road. The wash bay consists of a high pressure washing system; a standpipe with treated effluent water supply; a concrete apron which drains into a soak-away via a sand trap and silt/ oil trap. The wash bay was initially intended to be available free of charge to all vehicles which delivered to the facility on a self-service basis. However only municipal waste delivery vehicles are now allow to use the wash bay due to vandalisms as well as high operational and maintenance costs. No vehicle transporting medical waste are washed at the bay at all in order to prevent that harmful organism are not retained on the wash bay structure and in the sewage disposal system.

2.1.7. Incinerator

The unit is located between the public disposal unit and the solid waste stores, on the opposite side of the road from the administrative building. This unit is not open to the public as it is considered an area where infectious materials is handled. The incinerator is a two chamber unit complete with feeding ram, fueled by diesel. It has a capacity of burning 150 kg General Refuse Equivalent (GRE) per hour in a smokeless, odorless and grit free manner. This is for the incineration of inter alia medical waste, condemned foodstuffs/carcasses, confidential documents and certain hazardous wastes where pathogens and toxins can be destroyed by high temperatures.

An adjacent working area is provided for the receiving and preparing of items to be incinerated. Potable water and a safety shower are provided. No freezing/cooling or storage facilities are provided, thus the operation of the incinerator is scheduled in advance with the receipt of waste for immediate incineration.

Operating hours for the incinerator unit are from 07:00 to 18:00 Mondays to Fridays and as mutually agree upon between the waste generator and the Hazardous waste Inspector and displayed on the information notice board at the Administration Building. After hours activities at the facility are limited to preparations and maintenance to the incinerator. No access is allowed to any other officials after hours.

Operation: The incinerator is charged through by a hydraulic operated ram which feeds into the pyrolytic zone of the primary chamber. Operation of the feed ram is fully automatic and is regulated by combustion conditions inside the incinerator so as to maintain an optimal feed rate. Provision is made to progressively and automatically move the burning waste and ash forward, over the hearth, the tuyeres and into the ash dump. The incinerator is fitted with an automatic riddling systems to screen and remove burnt-out ash from the incinerator. The ash is to be dumped automatically into a trolley which can easily be wheeled to an ash dump by one person. Provision is made for automatic closure of the ash dump opening while the trolley is removed.

Chimney: The chimney is mounted directly on top of the incinerator. The incinerator structure supports the weight and is designed to withstand the loads generated by winds up to 150 km/hr. without guy ropes, though these ropes were installed to limit movement and consequent damage. The overall height of the chimney is 12m above the base of the incinerator.

Maintenance Schedule: The incinerator is thoroughly inspected at the following periods/ after the following incidents:

- ✓ When de-contaminating the incinerator and housing
- ✓ After explosions

The inspection includes measuring of the inside thickness of the fire clay liner; cracks and mouse holes. Burner is checked each shift and photo cells are cleaned with a soft cloth after each shift. Electrodes, wiring and fuel lines are maintained clean and checked before each shift. Fuel ports and air holes are cleaned prior to each shift.

2.1.8. Public Disposal Unit

The Public Disposal Unit is available to the general public to deliver/drop-off refuse with small vehicles such as sedans, Light Delivery Vehicles (LDVs) and trailers (1 tonne or 5 m³ maximum). This Public Disposal Unit consists of paved drive through area, elevated approximately 1.3 m above the general ground level, with retaining wall on either side of the area. Skips are placed on the lower level, against the walls to receive waste dumped from vehicles on the upper level. The layout of the retaining walls is staggered in plan, to facilitate dumping from two sides into the skip. Rubber flaps are fastened to the walls to flap over the edges of the skips, thereby minimizing spillage of waste onto the ground.

Sufficient skips and containers, complete with signs indicating the type of waste to be disposed into each skip/container, are provided to promote separation of waste into different categories, thereby facilitating easier recycling/ reuse. The categories of general waste being disposed off at this stage include:

- General domestic waste
- Garden refuse
- Building rubble
- Scrap metal
- Cans
- Paper (paper/ carton)
- Glass (clear, green and brown)
- Plastic

Waste is dumped into the skips/containers which are then taken to the landfill, hazardous unit, or recycling yards. The filled skips are weighed and recorded as they leave the Entrance Component for the purpose of maintaining long term environmental records.

Provision is also made for the reception of oil used as fuel for the incinerator and or sprayed over the closed landfill area to fight wind corrosion and sometimes recycled by private contractors. Enclosed containers with identifying sign and instruction are also placed in this area for the disposal of hazardous domestic waste such as paint, batteries, fluorescent tubes, and etc. These containers are tamper free, preventing the uncontrolled removal of waste once deposited.

The public disposal unit is open at all times (including public holidays) to facilitate disposals of smaller waste quantities and thus minimizing the illegal dumping of waste elsewhere in the town. The security company monitors the abuse and control of the entire Entrance Component facilities. In general, the entire disposal activities are allowed from 07:00 to 18:00 Mondays to Fridays and 08:00 to 16:00 on weekends and public holidays. Access is allowed to the officials of Solid Waste section after hours. All access to the rest of Facility outside of the normal operating hours are controlled by locking the access gates. The attendee/security at the access gate guardhouse directs Light Delivery Vehicles (LDVs) to the Public Disposal Unit and all other vehicles to the weighbridge control during operating hours.

2.1.9. Stores and Garages

This area contains the garages, two storerooms, working area, ablution, mess and locker areas for the Municipality's Solid Waste Section staff members.

2.2. Hazardous Waste Disposal Component

Hazardous Waste cell is designed almost along the line of a mono-disposal and based on the 2nd Edition of the *South African Minimum Requirements for the Handling and Disposal of Hazardous Waste* and is classified as a H:H Hazardous Waste site. Based on current year-to-date quantities of the hazardous waste stream the hazardous waste unit has sufficient capacity for at least another ten (10) years of operation.

2.2.1. Layout

The hazardous waste unit is located on clean dune sand with a depth of approximately 10 m to the northeast of the General Landfill Component. The entire component is secured by means of a 1.8 m high precast concrete wall with lockable vehicle access gates at the entrance and comprises of a lined hazardous waste cell, a lined leachate pond and a hazardous waste reception building where the waste can be temporarily stored whilst being prepared for disposal in the cell. The evaporation/monitoring pond is adjacent to the hazardous waste storage cell and the hazardous waste reception/storage building. No ablution facilities are provided, but a safety shower and hand washbasin is provided inside the reception building.

2.2.2. Hazardous Waste Cell Design

The single pond Hazardous waste cell comprises of a lined bunded area of 3 800 m² with an average initial depth of 2 m. The capacity to the top of the bund walls is 7 000 m³ for a lagoon type operation. With the mono-disposal of up to a height of 9 m above the top of the bund walls, the total available volume of the cell is 18 000 m³. The components of the multi-layered geocomposite lining system hazardous cell liner are as follows from the top downwards:

- A 300 mm pioneer layer of refuse, sand-blasting grit or similar material to protect the liners to be installed by the Operator. This layer shall be stabilized to protect the liner layers on the inclined bund faces;
- Drainage layer of 19 mm stone, 100 mm thick;
- Woven polypropylene geofabric filter (approximately 200 g/m²);
- Drainage layer of 19 mm stone, 150 mm thick;
- Protection layer of non-woven geofabric (approximately 500 g/m²);
- Primary liner of 1.5 mm thick HDPE geomembrane;
- Geosynthetic clay liner (GCL);
- Woven polypropylene geofabric filter (approximately 145 g/m²);
- Protection layer of non-woven geofabric filter (approximately 250 g/m²);
- Secondary liner of 1.0 mm thick FPP geomembrane;
- Base preparation layer of fine sand, 100 mm thick, and
- Compacted in situ soil (gypsum gravel on compacted sand).

The liner system extends up the sides of the bund walls and is anchored in a trench on top of the walls.

2.2.3. Hazardous Waste Cell Drainage

The base of the cell is sloped from the middle outwards leachate collecting drainage at the foot of the cell bunds. A perimeter system of perforated leachate collector pipes is placed within the stone drainage layer, to discharge into the leachate pond via a solid walled HDPE pipe. The leachate drainage is provided with inspection eyes to facilitate cleaning if required/ as scheduled. The landfill of the cell shall include a drainage column at each corner to facilitate the drainage of leachate into the drainage collector pipes.

2.2.4. Hazardous Waste Cell Leakage Detection and Pond

The geonet drainage layer between the primary and secondary lines represents a leakage detection system should the primary liner fail in any way. Within this layer are perforated HDPE collector pipes, which drain into a leakage detection manhole, and ultimately into the leachate pond. Leachate and surplus water from the hazardous cell drain into the leachate pond where it evaporate. All leachate evaporates without the need for recirculation or treatment on account of the extremely arid climate. If, however, it is found that the build-up of leachate is faster than the rate of evaporation, it may become necessary to install a pump and spray the leachate back onto the hazardous cell.

The leachate pond comprises a lined bunded area of 256 m², with an average depth of 1 m, and thus a capacity of 210 m³. The lining system for the leachate pond is similar to that of the hazardous cell, except that a stone drainage layer is not required, and that the primary liner has an increased thickness of 2 mm. A 100 mm layer of stabilized sand is required over the primary liner as a ballast to keep the membrane down and as protection against wind erosion. The components of the leachate pond liner are as follows:

- Ballast layer of fine sand, 100 mm thick stabilized with cement;
- Primary liner of 20 mm thick HDPE geomembrane;
- Geosynthetic clay liner (GCL);
- Woven polypropylene geofabric filter (approximately 145 g/m²);
- Protection layer of non-woven geofabric (approximately 250 g/m²);
- Geonet drainage layer (for leakage detection);
- Secondary liner of 1.0 mm thick FPP geomembrane;
- Base preparation layer of fine sand, 100 mm thick, and
- Compacted in situ soil.

The liner system extends up the bund walls and is anchored in a trench on top of the walls. The leachate pond also has a leakage detection system similar to the hazardous waste cell, which drains into a leakage detection manhole on the south east side.

2.2.5. Hazardous Waste Site Operations

Operating hours for the hazardous waste unit is from 07:00 to 18:00 Mondays to Fridays and as mutually agreed upon between the waste generator and the Hazardous Waste Inspector and displayed on the information notice board at the Administration Building. After hours activities at the facility are limited to preparations of the site and maintenance to equipment. Access to this entire component is only allowed to the Hazardous Waste Inspector after hours.

The sound management of this disposal site is based on the following principles:

- *Minimising impact on the natural environment* - The control of environmental nuisances such as smells, fires, insects, birds, rodents and litter. Preventing the pollution of ground and surface water.
- *Minimising social impact* - Constant communication with the communities to ensure mitigation actions in case of complaints.

- *Maximising the use of available space* - Compaction of waste where feasible to optimize the use of available volume and to reduce the risk of nuisances occurring. Reducing volumes landfilled in the disposal pond.
- *Maximising of recycling/ reuse/ waste-to-energy* - Storage of potentially recoverable materials.
- Expenses should be limited by utilizing available resources to the maximum.
- Continuous monitoring of the operation against requirements to take appropriate action as and when needed.

Method of waste disposal: The method of disposal at this site is by means of co-disposal of hazardous waste and general dry waste or sand. As only small volumes are anticipated, simple methods such as shoveling and mixing of waste and hazardous oils could be done to achieve a co-disposed mix.

Methods of Operation: Hazardous waste is only received during normal daytime working hours, but not during weekends or public holidays. All hazardous waste is declared to the Hazardous Waste Inspector (HWI) by the originators prior to delivery. The HWI is tasked to inspect all deliveries to the site for hazardous waste content.

Acceptance/Refusal of Waste: Prior to delivery, all hazardous waste consignments are categorized by a laboratory assessment to determine the need for any pre-treatment and special handling, and hence disposal cost. This information is included with the manifest documentation.

Unacceptable Waste: Radio-active and extremely hazardous waste that represent a safety hazard for the workers on the landfills is not accepted at the site without the waste having been pre-tested at source to render it immobile, less toxic or less reactive. These waste would include high and low pH substances such as acidic-oil sludges, caustic sludges, etc.

Leachate Control: All leachate and leakage detection drains are maintained to be free of blockages. The HWI undertakes regular inspections and keep a log of such inspections. The pipes are washed to remove sediments at least twice a year. The cleaning operations and results are logged. Rodding irons are not used, as this cause damage to the pipes/linings. All leachate evaporates without the need for recirculation or treatment on account of the extremely arid climate. If, however, it is found that the build-up of leachate is faster than the rate of evaporation, it may become necessary to install a pump and spray the leachate back onto the hazardous cell.

IMPORTANT NOTICE

Before any liquid waste is discharged into the hazardous cell, and before any vehicle or equipment enter the cell, a pioneering layer of 0.3 m thick of selected domestic waste, sandblasting grit or sand is placed over the stone drainage layer to prevent any mechanical damage to the liner. The layer is stabilized either with cement, or with old oil.

2.3. General Waste Landfill Component

This Landfill Component is a standard facility and classified as a G:M:B General Waste Site in terms of the 2nd Edition of the *South African Minimum Requirements for the Handling and Disposal of Hazardous Waste*. The area includes:

- The dune landfill cells;
- An ablution block;
- A site operator storage and network building, and work area;
- Six recycling stalls, each with a small lean-to and a fenced in area, and
- Fencing against windblown litter.

2.3.1. Landfill Development

The first cell of the General Landfill Component was opened up by the construction Operator, whereas addition berms /cell walls were constructed and or opened with building rubble or stabilized sand to a height of approximately 2 m above the basis of the cell as the landfilling process progresses. A second cell is usually opened up once the first lift (layer of about 1.5 – 2.0 m) of the first cell has been deposited to the full length of the cell. The fencing of the cell walls is usually between 30 m and 50 m, depending on the volume of traffic at the disposal face. The number of operative cell so opened are minimize to not more than three at any stage due to the ingress of sand. A separate area (not cell) is reserved for the storage of tyres for possible future recovery for waste- to-energy conversion as fuel. (Tyre-storage area).

A mobile fence of poles and plastics coated diamond mesh is erected to prevent windblown litter from leaving the disposal cells and or area.

2.3.2. Recycling Stalls

Six recycling stalls of 20 x 20 m size, fenced with prefabricated concrete fencing are provided for recycling operations with a small lean-to for shelter. Metered potable water, purified effluent and electricity are available at each recycling stall, which stalls can be extended towards the back (away from the entrance) at the cost of the recyclers. The recyclers may erect additional temporary or permanent buildings and structures such as plants and shelters on site. General waste enters the landfill site and is separated on the landfill site by scavengers turned into “Formal Recyclers”. The Walvis Bay Municipality permits a few recycling companies to recycle at the landfill site in order to extend the life span of the landfill as well as for socio-economic reasons e.g. job creation. All permitted recycling companies buy recyclables from the scavengers/formal recyclers. These scavengers/formal recyclers also engaged into turning waste into “valuables” such as wood into furniture; building rubble into bricks; tyres into animal troves and sandals, and etc. In permitting recycling companies to reclaim or salvage recyclables from the landfill site, the Municipality requires a comprehensive proposal/ business plan, with their tender indicating:

- Which specific type of materials to be recycled?
- Which additional infrastructure to be erected?
- What pollution control measures will be instituted?
- Vagrant and scavenging control measures.

In addition, the following conditions are attached to any recycling/ salvaging operation:

- Salvaging takes place inside the cell, with the salvaged materials stored in fenced-in areas at positions indicated for such use by the landfill site operator.
- Salvaged materials are removed from the cell on a daily basis- materials not removed by the commencement of the operation each morning is immediately landfilled by the landfill site operator without informing the recyclers of this action.
- Salvaging is only allowed on the general waste unit and not on the hazardous unit.
- Labour appointments gives preference to the scavengers/informal recyclers on site, or if such are not available, shall give preference to Walvis Bay citizens.
- All appointments should be in compliance of the Labour Act.
- All personnel are clearly identified by the clothing worn.
- Persons not identified as stated above, are removed/ asked to leave by the Hazardous Waste Inspector and or the landfill site operator.

2.3.3. Ablution

Ablution facilities are provided next to the recycling stalls for use by all site stakeholders. The ablution is provide with its own septic tank and soak-away. No lockers or mess facilities are provided.

2.3.4. Operator's Yard

A site of approximately 50 × 50 m square is provided just to the south of the Hazardous Waste Component, next to the access road to the landfilling area. The site is situated such that the equipment used by the Operator does not need to be run on access road, but instead on a track next to the road, to protect the surface of the road. This Unit is (partially) fenced in with 1.5 m high prefabricated concrete sections, with an access gate. Facilities for the storage/maintenance of equipment/vehicles of the Operator is provided, as well as a storage room for lubricants/tools and a toilet/washing trough. Metered electricity, potable water and purified effluent are available for this unit.

2.3.5. Gas Harvesting

Due to the aridity of the area, fermentation of the waste is not expected to be sufficient to allow any methane harvesting, thus no collecting pipes were installed.

2.3.6. Site Life

Because of its location within the dunes, it is believed that there is more than ample cover requirement of approximately 473 000 m³. In addition, additional cover material is included in the incoming waste in the form of builder's rubble, waste soil and salt. The landfilling site has a 30 year design period assuming that no reduction in the landfill waste volume resulting from composting, recycling and re-use activities such as waste-to-energy activities. Considerations taken into account are the vast extent of desert around the site; a maximum landfill height of 12 m; a base area of between 19 and 24 ha, and an estimated total volume of 2 838 000 m³ general waste generation rate within the 30 years.

NOTE

The above estimates were made in hand with the available information for waste disposal in Walvis Bay only. Should external sources of waste be required to be landfilled, the life expectancy of the landfill site may be altered. Since an increased volume provides a better economic environment for recycling and waste-to-energy operations, the landfill stream may be reduced, restored, or even increasing the life expectancy of then landfill site.

2.3.7. Operations

The Landfill site is a standard facility with the deposition of the waste within berms constructed of building, and covered with sand as intermediate cover material and gypsum gravel and salt as final cover material. In terms of the minimum requirements.

Access to the landfill and recycling area is open to the public during working hours, but only for the purpose of discarding waste. Recycling/recovery of waste is limited to only those people allowed by permit to perform such functions.

Sound management of this disposal site is based on the following principles:

- The control of environmental nuisance such as smells, fires, insects, birds, Rodents and litter.
- Constant communication with neighboring communities to ensure mitigating actions in case of complains.
- Compaction of waste, where feasible, to optimize the use of available volume and to reduce the risk of nuisances occurring.
- Prevent the pollution of ground and surface water.
- The operation of the disposal site shall always keep the future use of the land in mind.
- Expenses should be limited by utilizing available resources to the maximum.
- Continuous monitoring of the operation against requirements to take appropriate actions as where and when needed.

Methods of Waste Disposal: Methods used at this site is initially the trench method until where all possible cover material has been excavated and then it is changed to the ramp method to build a positive land form. The trenches are then excavated and materials excavated from the trenches are used as cover material to augment the cover material that is available from outside due to building and excavation operations in the town, as well as dune sand from the desert. On completion the cell is covered with layer of gypsum gravel (and discarded salt when available) to encapsulate and seal the cell against wind erosion.

Construction and operation of the cell: The basic operating unit of this landfill is a cell. The sides are usually formed by 2-3 m high berms constructed from soil or rubble. The waste is deposited between the two berms of heights not exceeding 2 m. A series of adjoining cells to the same elevation are termed a lift. The working face (tip-face) is the active part of the landfill where waste is deposited by incoming vehicles. The width of a working face is usually about 30 m, and determined by the maneuvering requirements of the vehicles depositing waste and the number of vehicles which are to be accommodated at any one time. There is at all times sufficient cell capacity to accommodate at least one week's waste.

The general rules for the operation of a cell are:

- Depositing the waste as close as possible to the working face at the bottom of the face.
- Allowing just sufficient time for the recovery of recyclable/ re-usable materials from the waste.
- Recovering all tyres from the waste stream and transfer to the tyre disposal area.
- Flattening large and hollow items.
- Spreading the waste against the working face with gradient of at least 1 in 7 so that any rainwater can drain away.

The Trench Method is also being used where a trench is excavated and soil is stockpiled for use as cover material. Excavation is limited to about 500 mm above any groundwater layer. The vehicles deposit their loads into the trench and the waste is spread and compacted up a slope of 1.7 in layers 400 mm to 600 mm deep. The trenches are excavated on an ongoing basis as the cell length progresses.

Surface runoff control: Although Walvis Bay does not experience a lot of rainfall, all measures possible are taken to prevent the contamination of unpolluted surface water by diverting runoff away or around the landfill.

Prevention of nuisances: Dust, smells and windblown litter are the main nuisances that normally create a negative public reaction against a site. Ample cover material is available on the site to facilitate the daily covering of waste to prevent odours, flies and other pests and to prevent windblown litter. Environmental management and control of the operation are essential to ensure that the landfill is operated to acceptable standards. Some of the common short-term problems associated with landfill operations and their possible solutions, are listed below.

Dust: On-site roads are wetted in hot dry weather to reduce dust from traffic. In addition, all loads of waste which may form dust is covered with netting/ tarpaulin to prevent dust spreading.

Odours are generated as a result of biological degradation of materials. Daily covering of the waste with dune sand and the maintenance of this cover ensures that both fresh and decomposed waste do not become a problem. Putrescible waste is trenched and covered immediately.

Fires: The burning of waste is prohibited. Compaction and covering of waste minimise the fire risk by minimising oxygen exposure. Where fire do occur, the burning waste is exposed, spread and smothered with cover material. On no account is water added unless approved by the Fire Brigade Department.

Flies and rodents: Immediate compaction and daily covering of waste reduces the likelihood of this becoming a nuisance. Nevertheless, flies are commonly associated with landfill sites, thus pesticides is used to control this problem.

Litter: Compaction and covering of the waste reduces the risk of windblown litter. Litter screens are also used to control litter. All windblown litter are collected from around the site on regular basis. In the past, the lack of daily cover, in the junction with high winds, has resulted in windblown litter being spread over a wide area, particularly in the liquid

waste disposal wetlands. The lack of cover also resulted in offensive odours emitting from the site as well as the breeding of flies and vermin, whilst fires started illegally on the site (by scavengers) resulted in air pollution (mainly toward Narraville) and even lead to veld fires in the reedbeds of the liquid waste disposal wetlands. These problem have been curtailed to a large extend during the last few years, but rehabilitation of the surrounding area has not been complete.

Health: Medical waste is not permitted on the site and putrescible waste is covered immediately. Appropriate protective clothes and equipment is used by the site staff.

Drainage: Waste deposition is in such a way that it ensures that water runs away from the waste body, and does not form ponds on top of the waste, from where it might infiltrate. Though the rainfall in Walvis Bay is minimal, falls off up to 50 mm and more were once recorded some historic years back.

The landfilling unit is open at all times (including public holidays) to facilitate disposals of larger waste quantities. The Landfill Component facilities are monitored and control by an appointed contractor. In general, the entire disposal activities are allowed from 07:00 to 18:00 Mondays to Fridays and 08:00 to 16:00 on weekends and public holidays. The “Operation and Control of the Walvis Bay Municipal Refuse Landfill Site” is outsourced to external service providers on a 2-3 yearly basis under certain conditions (note Annexure B) and audited on a weekly basis (note Annexure C) by the Hazardous Waste Inspector, which duties were initially assigned to the Foreman: Solid Waste.

2.4. Civic Waste Facilities and Services

2.4.1. Security

A perimeter fence wall, complete with lockable entrance and exit gates have been provided around the entrance component, the hazardous waste disposal component and recycling stalls only **but not around the entire landfill site, which fencing is a legal requirement**. Electronic surveillance for the administrative building, garages, hazardous waste store are in place. Joint security service for all municipal facilities by a single security service is being implemented by the Municipality to protect all its premises (including the Walvis Bay Solid Waste Disposal Facility - WBSWDF).

2.4.2. Water Supply

Metered potable water and purified effluent are provided to all components and some units. Fire hydrants with potable water are provided. Any additional water pipe reticulation on site required by relevant stakeholders, over and above that already provided, can and are constructed at own costs.

2.4.3. Sewerage and Drainage

Sewerage from all the ablution facilities (e.g. administration, incinerator, recycler’s stalls and operator’s units) is discharge into septic tank systems. Effluent from the septic tanks is discharged through soak-away trenches **and is not connected to the municipal liquid waste disposal reticulation, which connection should be**

affected in the long run. Wash water from the vehicles wash bay discharges to soak-away trenches via sand and oil traps.

No formal drainage system were introduced at the General Landfill Unit, nor will any be required due to the low rainfall in the area. Drainage preparation, monitoring and maintenance is however installed at the Hazardous Waste Disposal Component.

2.4.4. Electricity Supply

Metered 3-phase and single phase electricity are available from the substation to the various Facility components and units, and is under the control of the Erongo Regional Electricity Distributor (Erongo RED) as no stand-by electrical power is provided or required.

2.4.5. Housing of Employees

No person is allowed lodging at the Disposal Facility and thus no housing facilities are provided or erected.

2.4.6. Roads and Parking Areas

The road to the WBSWDF has recently been upgraded from a gypsum road to a good quality 8 m wide tarred road. The road-ways and parking areas in the Entrance Component were also upgraded from gypsum gravel hard to brick-paved surfaced. The ramp of the Public Disposal Unit is brick-paved, to allow cleaning of the areas. Parking areas are provided:

- At the administrative building for staff and visitors;
- Just after the weighbridge as a holding area for unclassified waste;
- At the incinerator for deliveries and fuel supply, and
- Inside the Solid Waste Section Unit.

A gypsum gravel access road connects the Entrance Component, the Hazardous Waste Component and the General Landfill Component. Gypsum roads are provided within the Landfill Component to serve the Recycling Stalls, the Operator's Unit and the access to the Landfill Unit. The surface at the Landfill Unit for the delivery vehicles to maneuver is hard surfaced with gypsum gravel and/ or salt.

3. MANAGEMENT AND REMEDIAL MEASURES

3.1. Introduction

The potential environmental impacts associated with the continuous development and operation of this waste landfill site were identified through years of operation experiences. This entire Landfill Environmental Management Plan (LEMP) was thus developed based on operational experiences and confirmed through a top desk environmental assessment. The Municipality thus considered the environmental impacts and required mitigation measures for upgrading and development of the existing site into an environmentally acceptable waste disposal facility. The objectives of this site-specific LEMP are therefore to:

- Summarise the negative impacts that were identified;
- List the associated management actions necessary to minimize negative impacts;
- Identify responsible person/ party for implementing the required actions, and
- Identify monitoring requirements to ensure the management actions are implemented.

This entire Draft LEMP also fulfils the minimum requirements in terms of clause 8(j) of the national Environmental Impact Assessment Regulations.

3.2. Overriding Management Recommendations

The several environmental considerations and potential impacts that will be dealt with by way of ongoing management actions are listed below.

3.2.1. General Landfill Site Information

The municipality erect one upgraded/improved on weatherproof information notice board at the entrance. The notice board will reflect at least the information tabled in the Table below. The municipality will be responsible for effecting alterations to the board to ensure that the information displayed thereon is current and for maintaining the board in good conditions.

The notice board will state the names, addresses and telephone numbers of the permit holder and the responsible person, the hours of operation, tariffs and emergency telephone numbers, the class of landfill and types of waste accepted, as per sample below.

MUNICIPALITY OF WALVIS BAY SOLID WASTE DISPOSAL FACILITY							
Facility Unit	Operator	Tariff	Business Hours	Contact Person	Contact Number	Emergency Number	Waste Accepted
Entrance Boom							
Weighbridge							
Wash Bay							
Incinerator							
Hazardous Waste							
Recycling Glass							
Recycling Metal							
Recycling Paper							
Recycling Plastic							
Recycling Oil							
Solid Waste Section							
Water Section							
Fire Brigade							

3.2.2. Concerning Waste Management

Compaction of waste and cover material

Modern waste management practices require the daily compaction of waste and cover materials to reduce the volume of waste, thereby increasing the life-span of waste disposal site. Considering the waste stream involved, and the cover material applied, sufficient compaction is expected to be maintained with the earth-moving machinery used on the site.

3.2.3. Concerning Geohydrological Conditions

Contamination of Groundwater

Contamination through leachates could pollute the underlying ground water. Although not recommended in the *National Solid Waste Management Strategy for Namibia* the establishment of permanent (capped) groundwater monitoring boreholes, one up-gradient and one down-gradient on the groundwater flow, shall be investigated for feasibility and practically at the landfill site and hazardous waste cells. The boreholes would then be sampled on an ongoing basis.

3.2.4. Concerning Biophysical Conditions

3.2.4.1 Fauna, Flora and Natural Habitat.

All access roads will destroy desert habitat proportional to the surface area. Therefore:

- The area of any construction and or operation shall be confined to the smallest possible space.
- Well defined, single access roads shall be established, maintained and used throughout the life of the site.

3.2.4.2 Sand Movement

The following management actions are continually recommended to mitigate the effects of dune encroachment and wind-blown sand:

- Implementation of engineering and architectural design criteria that would limit, and where necessary, aid the efficient removal of windblown sand.
- Implementation of dune management strategies such as leveling and gravel covering of areas.
- Construction of the landfill cell with a long axis perpendicular to the predominant wind direction from the south east, and propagation of the cells into the wind direction to avail maximum use of the wind driven sand cover material.

3.2.5. Concerning Social Factors:

3.2.5.1 Negative Impacts on Visual/Aesthetic Appearance of Desert

Plastic and paper waste material dumped at the landfill site, if not controlled, is dispersed by prevailing winds. Plastic bags and paper visually degrade the natural landscape when blown into the desert and onto roads. The management actions recommended to mitigate the visually degradation of windblown materials carried from the site are as follows:

- Waste disposal trucks are equipped with suitable coverage (e.g. heavy netting) to avoid litter being blown into the desert during the transportation of waste from all the suburbs to the site.
- The feasibility of implementing a recycling programme at source (waste material to be separated at source by facilitating the effective management of lightweight materials at site) shall be assessed, facilitated and promoted.
- Recycling operations are facilitated on or closest to the landfill site.
- Waste is covered systematically immediately after being disposed and the recycled materials have been removed.
- The work face area is minimized.
- The operating work face area is predominantly north-facing to reduce exposure to the predominantly south/south-west winds.
- A wind-litter catch (approximately 1.5 m high and as wide as the working face area) is placed downwind (nothing the two predominant wind direction for windblown waste (e.g. plastics).

3.2.5.2 Impacts Related to Security and Access Control

This Class 1 waste disposal facility (HH site) is a potentially dangerous place due to the presence of hazardous waste. Contamination can occur from contact with the vectors of diseases such as bacteria, flies, mosquito and rats. Furthermore, heavy machinery used on site may cause accidents. Therefore, it is essential that the waste landfill site has an adequate access control and security system. This would prevent unauthorized entry and reduce the risk of injury/ damage.

The following management actions apply:

- Waste pickers are not allowed on the hazardous cell area.
- Only authorized waste recyclers are allowed on the landfill site.
- 24 hours security has been established and a permit system instituted.
- Suitable signage to warn personnel and visitors of the potential dangers of the hazardous landfill site is erected and maintained.
- No vehicle is allowed to approach any earth moving equipment closer than 30 m without specifically being instructed so by the landfill site operator's staff of the earth moving equipment.

3.2.5.3 Negative Impact Resulting from Odour

Different odours are released from various sources on the refuse landfill site. Pungent gases can irritate eyes and lead to a range of health complaints such as appetite loss, vomiting, nausea and an inability to concentrate. Odours can also last for long periods in clothes and materials thereby extending impact of thereof.

Management actions recommended apply:

- Cover wet waste trenches on a regular basis.
- Minimise the surface area of the work faces.
- Minimise the exposure time of waste in the air.
- Introduce special cells for odorous compounds with minimum exposure to wind.
- Treat hazardous wastes before disposal.
- Cover all waste on a daily basis.

3.2.5.4. Impacts Related to Workers' Health and Safety

Personnel working on a hazardous waste landfill site are exposed to vectors of diseases and safety risks. This includes the incineration of medical waste.

The relationship between health and improper storage and disposal of waste materials has long been recognized. Rats, flies and other diseases vectors breed in open refuse disposal sites where food and harborage are available. Among diseases that have been directly associated with open landfill sites are typhoid fever, Cholera and dysentery.

Another health effect is the occupational hazard to workers who provide waste collection and disposal services. These workers are exposed to typical health hazards associated with hazardous waste (e.g. chemical burns, skin disease etc.).

Workers also run the risk of injury from exposure to situation such as moving trucks and equipment, unstable surface areas, holes in the landfill and falling debris from the work face.

The management actions recommended to reduce occupational health and safety risks at the waste landfill site are, inter alia, as follow.

- Providing workers with adequate personal protective equipment and training them in the use of such and ensuring that the equipment is being applied where applicable as well as educating them regarding the risk involved in working with hazardous wastes they are exposed to.
- Erecting suitable signage to warn personnel of the potential dangers of the hazardous landfill site.
- Covering the work face with cover material and compacting on a daily basis to reduce vectors of diseases on both the general landfill and hazardous cell.
- Establishing biological health monitoring programme for workers.
- Minimising the numbers of workers working on the work face.
- Managing and controlling vectors of disease through regular spraying, dosing and baiting,
- Continuously providing suitable ablution facilities for workers.

3.3. Landfill Site Rehabilitation and Closure

After the landfill or a single landfill cell has reached its final capacity the waste is covered first by an intermediate cover layer, which is sensitive to settlements of the landfill surface. The functions of this intermediate cover layer (e.g. 50 cm of soil) are:

- Prevention of erosion by wind and water;
- Reduction of any possible water infiltration and gas emissions (at least partial oxidation of methane generated);
- Promote vegetation, which measure is not suitable to the Walvis Bay desert environment, and
- Enhancing aesthetic issues.

Although not necessary, in the Walvis Bay desert environment, the reduction of water infiltration rates can be accomplished by a cover material of high water retention capacity (e.g. compost material), by profiling the surface (establishing a relatively large slope of 5 to 10%) and/or intensive vegetation. After 5 to 20 years (depending on the settlement development) the intermediate cover could/should be replaced and overlain by a top sealing system (e.g., clay liner of 50cm and soil layer > 50 cm), which further reduces the amount of water infiltrating into the waste. Again and ideally, a sufficient surface slope (>5%) as well as dense vegetation cover (in order to prevent erosion) are recommended for the final capping of the landfill.

After the closure this landfill is to be managed and controlled in order to avoid adverse effects on humans and the environment. This post-closure care (or landfill aftercare) will have to be prolonged as long as landfill emissions represent a hazard to human health and the environment. The duration of this post-closure care is estimated to be in the range of several decades to centuries. This is due to the fact that the so called liquid to solid ratio (gives the amount of water in liters that has passed through 1 kg of dry solid waste) is largely determining the duration of the landfill aftercare.

Nevertheless, regular monitoring and maintenance after landfill closure will be required to ensure that the closed landfill does not cause any risk for the environment. Post-closure monitoring will likewise to the operational phase focusing on water (leachate and groundwater) and gas monitoring. In addition the status of different landfill elements should also be observed, such as final cover integrity, drainage system, any possible vegetation, slope, etc.

Nonetheless the above theoretical and ideal final cover application and post-closure care envisaged future situation, the Municipality of Walvis Bay has embarked upon more practical reuse, recycling and waste-to-energy measures that serves as landfill site rehabilitation and closure remedial measures such as:

- **Waste-to-Energy Project:** The Municipal Council is in an advanced stage of entering into a Joint Business Venture with the aim of turning all the previous old and new incoming waste, of all the types, into energy. This entire project will have to comply to all relevant legislative requirements such as the Environmental Management Act No.7 of 2007.
- **Material Recovery Facility:** The Municipal Council allocated a piece of land adjacent to the Walvis Bay Landfill Site in 2015 to Rent-A-Drum for the establishment of a waster recovery facility which will enhance reuse and recycling activities within the entire town and landfill site. An Environmental Clearance Certificate (ECC) was also issued for this project to proceed in terms of the Environmental Management Act No.7 of 2007.
- **Old Tyres Recycling Project:** A number of different tyre recycling initiatives where proposed to the Municipal Council. The processing and or reuse of the significant stockpiled tyres is expected to kick-start within the new future although none concrete steps were taking by any of the proponents to date.

The present ongoing reuse and recycling activities on the Walvis Bay Landfill Site as mentioned in subsection 2.3.2 of this Draft LEMP and the initiation of the above mentioned three major projects will ensure the significant prolonging of the life span of the Walvis Bay Landfill Site and also serve as rehabilitation and closure measures.

4. SITE RECORDS AND LEMP REVIEW PROCESS

In terms of Task 1.1.6: “*Set up monitoring and reporting systems*” of the National Solid Waste Management Strategy, a database system is a critical component of the LEMP as the management plan will refer to operational records and reports, design information and monitoring reports, shall become the site records for the Walvis Bay Landfill Site. The site records will be referenced within the management plan on a regular basis. The format of the database system will facilitate ease of reference to the site records and incorporate a process for identifying superseded documents,

The review period for this landfill site’s LEMP will be on an annual basis, however the main review period will be every three years to coincide with the validity period of the Environmental Clearance Certificate (ECC) or as otherwise specified in the ECC.

Given the ongoing records keeping, monitoring and reporting associated with the landfill site, the review of the LEMP should demonstrate that the sufficiency of the operational, design and monitoring systems for the current operations of the site has been addressed. The review process will be established to ensure continual improvement in the management and operation of the landfill site. The LEMP review process (for example, a checklist system) will assist in identifying the outcomes from site investigations, operational reporting and/or monitoring programs and so on for incorporation in the management plan as appropriate. As a result, the outcome of the draft LEMP review process may be that only specific sections of the management plan may be subject to revision and submission to the Environmental Commissioner for approval.

It is thus appropriate to conclude that the Municipality of Walvis Bay (WBM) will take the overall responsibility to ensure that all LEMP specified actions are properly implemented, monitored and recorded. All key role players such as the WBM staff involved in the day to day operations of the waste disposal site; all waste contractors, and recyclers on site will be informed about the contents of this LEMP and activities to be undertaken. The WBM will ensure *compliance to Part VI of the Environmental Management Act No.7 of 2007 (EMA)* that deals with Environmental Plans. In addition, *adherence to this LEMP* will result in a well-managed landfill site, which in turn will minimize operational costs and future potential negative impacts and threats to the environment and public.

5. REFERENCES

Darryll, K., Karen, H., Lynton, B. & Maretha, S. 1996, *Environmental Assessment of the Walvis Bay Development Project EEU Report No 17/96/164*. University of Cape Town, South Africa.

Nehemia, J., Piet, M. & Van Wyk, W. 2001, *Tender Document 81: Operation of Walvis Bay Waste Disposal Facility*. Walvis Bay, Namibia.

ANNEXURE A: Incinerator Specs & Operations

ANNEXURE B: Landfill Site Operation & Control

ANNEXURE C: Landfill Site Audit Form